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Terrestrial imagery as ground-truth data sets for the validation of Earth Observation products: the snow monitoring system in Sierra Nevada (Spain)

María José Polo (1), Rafael Pimentel (2), María José Pérez-Palazón (1), and Javier Herrero (1)

(1) University of Cordoba, Andalusian Institute for Earth System Research, Cordoba, Spain (ag1pogom@uco.es), (2) Swedish Meterology and Hydrology Institute, SMHI, Norrköping, Sweden

The increasing number of satellite missions launched for the monitoring of environmental variables provides the scientific community with a wide variety of data sources ranging in frequency and spatial resolution. Moreover, recent works show the challenging opportunities for retrieving long to medium-term time series of key hydrological variables from the joint use of different sensors, especially from the current high spatial resolution sensors since the last five years. However, the availability of sound standardized data sets to verify the algorithms that provide the target variables from the spectral information in the images keeps being a key issue for the validation of the newcoming products.

Snow resources play a key role in the hydrological regime in mountain areas. In Mediterranean regions. The record of snow cover fraction in these areas from indexes such as the NDSI has led to Landsat and MODIS products to monitor the snow cover area evolution; furthermore, fusion algorithms to fully exploit the information from both data sources are developed. The possibility of retrieving wet/dry snow maps from combining optical and radar sensors do offer a huge range of possibilities to explore triggering processes in snow dynamics. The availability of ground data to further assess their accuracy and range of application is not usually feasible in mountain areas, due to limited access.

This work presents the snow monitoring network in Sierra Nevada (Spain) as a ground-truth data source for the retrieving and validation of snow maps algorithms. Selected locations were used to install time-lapse cameras focused on different spatial scales in this area above 1200 m a.s.l., from whose scenes targeted process-oriented state variables are retrieved on a continuous basis: a 30x30m time series of snow cover area for the modelling of snow processes on the subgrid scale (from Landsat reference) in the Refugio Poqueira control point; a 2 km2 reference area in El Caballo hillslope to validate fractional snow cover maps from different algorithms/satellite sensors sources; and replicates of these scales on different points throughout the study area. The results include the direct validation of NDSI and spectral mixture models for retrieving of snow maps from Landsat, MODIS and Sentinnel data, and the assessment of wet/dry snow maps from Sentinnel data by the analysis of changes in selected control points. The results offer a sound framework to derive ground truth data with different spatial resolution that can be easily adapted to the source data to validate, by simple adjustment of scene area to capture.
The snow cover maps time series from 2009 in Sierra Nevada-Spain offer a validated reference data set to test the accuracy of snow products algorithms in complex environments such as the steep topography found in the study area.