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Snow Water Equivalent estimation based on satellite observation

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The availability of remotely sensed images and them analysis is a powerful tool for monitoring the extension and typology of snow cover over territory where the in situ measurements are often difficult. Information on snow are fundamental for monitoring and forecasting the available water above all in regions at mid latitudes as Mediterranean where snowmelt may cause floods. The hydrological model requirements and the daily acquisitions of MODIS (Moderate Resolution Imaging Spectroradiometer), drove, in previous research activities, to the development of a method to automatically map the snow cover from multi-spectral images. But, the major hydrological parameter related to the snow pack is the Snow Water Equivalent (SWE). This represents a direct measure of stored water in the basin. Because of it, the work was focused to the daily estimation of SWE from MODIS images. But, the complexity of this aim, based only on optical data, doesn't find any information in literature. Since, from the spectral range of MODIS data it is not possible to extract a direct relation between spectral information and the SWE. Then a new method, respectful of the physic of the snow, was defined and developed. Reminding that the snow water equivalent is the product of the three factors as snow density, snow depth and the snow covered areas, the proposed approach works separately on each of these physical behaviors. Referring to the physical characteristic of snow, the snow density is function of the snow age, then it was studied a new method to evaluate this. Where, a module for snow age simulation from albedo information was developed. It activates an age counter updated by new snow information set to estimate snow age from zero accumulation status to the end of melting season. The height of the snow pack, can be retrieved by adopting relation between vegetation and snow depth distributions. This computes snow height distribution by the relation between snow cover fraction and the forest canopy density. Finally, the SWE has to be calculated for the snow covered areas, detected by means of a previously developed decision tree classifier able to classify snow cover by self selecting rules in a statistically optimum way. The advantages introduced from this work are many. Firstly, applying a suitable method with data features, it is possible to automatically obtain snow cover description with high frequency. Moreover, the advantages of the modularity in the proposed approach allows to improve the three factors estimation in an independent way. Limitations lie into clouds problem that affects results by obscuring the observed territory, that is bounded by fusing temporal and spatial information. Then the spatial resolution of data, satisfactory with the scale of hydrological models, mismatch with the available in situ point information, causing difficulties for a method validation or calibration. However this working flow results computationally cost-effectiveness, robust to the radiometric noise of the original data, provides spatially extended and frequent information.