Geophysical Research Abstracts
Vol. 15, EGU2013-9884, 2013
EGU General Assembly 2013

An original methodology to compute SWE of mountainous regions: insight from the Italian Eastern Alps

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In this work we present an original methodology for the evaluation of the Snow Water Equivalent (SWE) from regions covering an area of about 5000 km2. The methodology has been tuned and set up over the Italian Eastern Alps using MODIS satellite images (http://rapidfire.sci.gsfc.nasa.gov/realtime/) and data derived from the monitoring network of the local Snow Avalanche Services. The methodology includes: i) the identification of the Snow Covered Area (SCA) from satellite images; ii) the near real-time computation of the snow depth (Hs) mean values from the available monitoring networks; iii) the derivation of the mean snow density by season and by depth interval.

Satellite image processing for the computation of the SCA has been tuned up specifically for the Eastern Alps region and includes the computation of the Normalised Difference Snow Index and a threshold value ad hoc for the investigated area; the use of a Decision Tree. The identification of the most effective (the best) threshold value is the most sensitive part of the image processing because this threshold depends on many factors such as the local physiographic setting, the altitude intervals, the shadows, and the vegetation. By comparing the obtained SCA map with the digital elevation model of the investigated region it is possible to derive the snow covered area by altitude intervals.

Italian Snow Avalanche Services control networks for the monitoring of the Hs over their competence. Those networks are based on real time automatic measurement systems or snow field where manual measurement are daily performed every morning. From those measurements are then derived mean Hs values for altitude interval (every 300 m starting from 600 m elevation in the Eastern Italian Alps). The altitude intervals are chosen based on the physiographic setting and the local climate of the investigated region.

Snow density values are derived from long time-series data base where measurements from the Italian Alps are classified by snow depth and by season. In this way it is possible to derive a statistical, predictive tool for the evaluation of the mean snow density by snow depth classes, by altitude interval, and by season in the Eastern Alps.

The SWE by altitude interval and/or by season and/or by sub-regions in the investigated area is then computed as the product of SCA, of the mean Hs, and of the mean snow density.
Despite the precision that can be improved with the availability of higher spatial resolution satellite images, this methodology allows to quickly compute near real time SWE for vast regions using multispectral satellite data freely available in the internet and the Italian Avalanche Services data base. This methodology may be easily tuned and applied in other mountainous regions where Hs and snow density values are available from local Snow Services.