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Monitoring the variation of snow cover distribution with spot-vegetation images over the French Alps during the 2000 winter season

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Estimation of the Snow Covered Area (SCA) is an important issue for meteorological application and hydrological modeling of runoff. With spectral bands in the visible, near and middle infrared, the SPOT-4 VEGETATION sensor can be used to detect snow cover because of large differences between reflectance from snow covered and snow free surfaces. At the same time, it allows separation between snow and clouds. Moreover, the sensor provides a daily coverage of large areas.

However, as the pixel size is 1km x 1km, a VGT pixel may be partially covered by snow, particularly in Alpine areas, where snow may not be present in valleys lying at lower altitudes. Also, variation of reflectance due to differential sunlit effects as a function of slope and aspect, as well as bidirectional effects may be present in images. Nevertheless, it is possible to estimate snow cover at the sub-pixel level with a relatively good accuracy and with very good results if the sub-pixel estimations are integrated for a few pixels relative to an entire watershed.

This approach has been first applied over rolling hills and plain areas in Southern Québec, Canada, and later over mountainous areas in Lebanon. Application of this approach in the French Alps (N 45˚.20' / E 6˚.15') is now presented with corrections for sunlit effects using either a 1000-m or 20-m DEM. The general objectives of the study are (i)estimation of surface variables using data from a medium spatial resolution and high frequency remote sensing sensor in orbit and (ii) increase accuracy of spatial positioning for multitemporal analysis of data.

Data from the 1999-2000 Winter are used. More than 20 relatively cloud-free VEGETATION images were available from the beginning of January to the end of August. Simultaneous high resolution HRVIR images were also available for the same period, allowing estimation of the accuracy of estimated snow cover percentages over each VEGETATION pixel as well as over larger areas like watersheds lying within the HRVIR image.

The results presented here are focused on the melting season (March to June). As an example, the shapes of the snow cover areas on both VGT and HRVIR images from the 17^{th} June 2000 are relatively similar and, if only pixels above 1800m are considered, the two estimations are between $\pm$ 10% for 53% of the pixels and less than $\pm$ 25% for 82% of the pixels, no matter if an illumination correction has been done or not.

If estimations are considered for groups of 2x2 and 5x5 pixels, then the agreement goes up, respectively, to 74 and 96% for a $\pm$ 10% difference between estimations and to 95 and 100% for a $\pm$ 25% difference.

Those results can be considered as quite satisfactory, given the problems encountered in mountainous areas. Representative snow cover maps are presented and discussed for three days representative of the variation of snow cover during the melt season, together with obtained accuracies.