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AMSR-2 and COSMO-SkyMed data integration for estimating snow depth at high resolution in Italian Alps

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Satellite microwave radiometers, as the SSM/I and the AMSR-E/AMSR-2, are recognized to be very suitable for global and regional monitoring of snow cover, and many efforts have been carried in past years for implementing retrieval algorithms to estimate Snow Depth (SD) and Snow Water Equivalent (SWE) (e.g. [1], [2]). However, the coarse ground resolution of these sensors makes it difficult to use them for monitoring snow in heterogeneous environments, as the Alps, which are characterized by dramatic spatial variations of the snow properties at sub-pixel scale.

This study aims at implementing a method to disaggregate the AMSR-2 brightness temperatures (Tb) using the ASI's Cosmo SkyMED (CSK) X-band SAR for estimating the snow depth (SD) at the same resolution of SAR images. The proposed active/passive (A/P) implementation is based on Machine Learning (ML) methods, by using an algorithm that merges AMSR2 and CSK to disaggregate the Tb basing on Artificial Neural Networks (ANN), and another one that estimates SD using the IFAC's HydroAlgo [3], and the disaggregated Tb, which is based on ANN and Random Forest regressors (RF).

The proposed method was implemented and validated in the Western part of Italian Alps (in Val D'Aosta region), by considering data acquired by AMSR2 and CSK during the dry snow period in the winter seasons 2020-2022.

The reference SD data needed for implementing and validating the method have been derived from a network of 36 weather stations managed by ARPA Piemonte, DEM and land use maps have been also considered as auxiliary information for the SD retrieval [4].

To assess the effectiveness of the proposed A/P technique, the SD retrievals have been compared with those obtained by estimating SD directly from CSK data. Taking advantage of the multifrequency information, the retrievals based on A/P method clearly outperformed those based on CSK data only: correlation increased from R=0.77 to R= 0.85 for the ANN based retrievals and from 0.76 to 0.86 for the RF based retrievals. The corresponding RMSE decreases from 34 cm to 28 cm and from 34 cm to 27 cm for ANN and RF, respectively, in a SD range between 0 and ≃220 cm.

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