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Estimate of snow density knowing grain and share hardness

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Alpine avalanche warning services produces, weekly, snow profiles. Usually such profiles are made in horizontal snow fields, homogenously distributed by altitude and climatic micro-areas. Such profile allows grain shape, dimension and hardness (hand test) identification. Horizontal coring of each layer allows snow density identification.
Such data allows the avalanche hazard evaluation and an estimation of the Snow Water Equivalent (SWE). Nevertheless the measurement of snow density, by coring, of very thin layers (less than 5 cm of thickness) is very difficult and are usually not measured by snow technicians.
To bypass such problems a statistical analysis was performed to assign density values also to layers which cannot be measured. This system allows, knowing each layer thickness and its density, to correctly estimate SWE.
This paper presents typical snow density values for snow hardness values and grain types for the Eastern Italian Alps.
The study is based onto 2500 snow profiles with 17000 sampled snow layers from the Dolomites and Venetian Prealps (Eastern Alps). The table of typical snow density values for each grain type is used by YETI Software which elaborate snow profiles and automatically evaluate SWE.
This method allows a better use of Avalanche Warning Services datasets for SWE estimation and local evaluation of SWE yearly trends for each snow field.