ABSTRACT

FRESH SNOW evaluation BASED ON DATA FROM AUTOMATED STATIONS
Description of a model aimed at improving evaluation of fresh snow depth based on reading of data from automated stations

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The amount of fresh snow, i.e. the measure of cm of fresh snow fallen in the last 24 hours, HN, is fundamental for the evaluation of avalanche danger and conditions of snowcover stability. The depth of fresh snow derived from the frequent measurements of snowcover carried out by automated snow and weather stations is basically underestimated. Such underestimation is mainly linked to the settlement processes taking place within snowcover prior to snowfalls resulting from the weight of fresh snow.

Manual snow observations carried out daily by operators (Model 1 - AINEVA) are only partially affected by this underestimation, as measurements are made using a wooden board, placed on the snowcover surface, that separates the snowcover settlement process from snowfall accumulations. The aim of this study was therefore to create an algorithm of adjustment of the fresh snow values provided by automated stations, using as a reference the fresh snow parameters modelled by SNOWPACK (Bartelt and Lehning, 2002), a one-dimensional numerical model developed by the Institute for snow and avalanche research (SLF) that simulates the snowcover evolution over time, taking into account the numerous snow and weather factors that affect it.

MEASUREMENT OF SNOWFALLS WITH RAIN GAUGES
Estimation of systematic errors and correction of historical series

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Precipitation measured by rain gauges is usually affected by a systematic underestimation of the real water volumes that reach the ground and which can be larger in case of snowfall.

The wind, disturbing the trajectory of the falling water droplets or snowflakes above the rain gauge, is the major source of error, but using tipping bucket recording gauges, induced evaporation due to the heating device should also be taken into account.

In Valtellina and Vallecamonica Alps, manual measurements of fresh snow water equivalent (SWE) have been compared with melted snow measured by rain gauges with manual recording and by mechanical and electronic heated tipping-bucket recording gauges without any wind-shield: all these gauges underestimate the SWE, in a range between 15% and 66%. In some innovative monitoring sites, instead, electronic weighing storage gauges with Alter wind-shields are coupled with snow pillows data: daily SWE measurements from these instruments are in good agreement. In order to reconstruct historical data series of precipitation affected by systematic errors in snow precipitation measurements, we tried out a simple model that applies a correction factor as a function of air temperature as an index of precipitation phase transition. The threshold air temperature values were estimated from a statistical analysis of snow fields observations. A correction based on wind speed would be less effective, due to limited availability of wind data. The correction model applied with daily resolution leads to 5-37% total annual precipitation increments, which grow with altitude above sea level and wind exposure.

ON DIGGING TECHNIQUES IN AVALANCHES
For a shared teaching methodology at all the Italian Alpine Club schools

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Avalanches are “democratic”. As everyone know, they make no distinction based on gender, and least of all based on the kind of activity carried out by people. Anyone who frequents snow covered environments, like snow shoes users, skiers or climbers, may be interested in attending a training stage that helps them face an emergency situation. This article illustrates the ultimate digging and excavation techniques applicable to the Italian Alpine Club schools and/or to the related areas.

The Central Ski Mountaineering School (SCSA) and the Italian Avalanche Service (SVI), in collaboration with the Lombard pool of Centro Studi Materiali e Tecniche (CSMT), the Research center on materials and techniques, by carrying out comparative tests onsite have found out the ideal solution based on the type of practiser who makes use of these techniques. At the Club schools users can be functionally subdivided into three categories: Novices, Experts and Instructors. The characteristics of efficiency, speed and flexibility for progressive learning, determined in the “V-shaped snow conveyor” method developed by Manuel Genswein, have been adapted to the teaching requirements of the lessons proposed at the Club schools, from the essential aspects to the specific ones. Starting from the base techniques (for Novices), it is then possible to learn how to face any special circumstance (for

Expert groups) and finally how to behave in the event that numerous trained operators are available (i.e. courses led by Instructors/Guides), therefore acquiring a technical and teaching methodology to be adopted by all the Italian Alpine Club schools.

A comparison between structural instability indices (Lemons) and ECT and RB stability test results

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Almost all avalanche forecasting services have a network of traditional stations where an array of daily or weekly snowpack measurements or observations are made (ram penetrometer, snow profile, stability tests). Ram penetrometer and snow profile data are classified as medium entropy type, while stability test are low entropy ones and they require an interpretation by the avalanche forecaster. In recent years, several methods have been developed to analyze the profiles and to evaluate, more objectively, snowpack stability identifying the weak layers and their characteristics and properties. During the period 2010-2013, several AINEVA regional offices have collected a dataset consisting of hundreds of snow profiles, each accompanied by side-by-side stability tests (ECT and/or RB). A sample of this data set was analyzed following the critical variables method and finding interesting relations between weak layer characteristics (structural instability indices or "lemons", grain type, layer thickness, weak layer properties) and stability test results. The preliminary figures of this research project are discussed here and they show that the best correlation between the highest values of the structural instability indices and stability test results can be found for weak layers that are formed owing to medium to high temperature gradient metamorphism. Less good correlations have been detected for weak layers composed by new snow (PP and DF) or by several types of crusts or smooth interface between layers. The complete data set has been finally analyzed to compare ECT versus RB effectiveness in discriminating the main weak layers and finding relations between load steps, fracture character and depth, quality shear and weak layer characteristics.

3PClim: CLIMATE CHANGES IN THE ALPS Data, situation and perspectives of climate in the alpine area between Tyrol, South Tyrol and Belluno area

P. Tartarotti

The vast area stretching from Tyrol to South Tyrol and northern Veneto boasts one of the highest densities of weather stations in the world but, compared with several neighbouring regions, has no current climate analysis of measurements and no synoptics of the climate changes on a regional scale. The last climatological analysis of Tyrol and surrounding areas dates back to 1975, with data collected between 1931 and 1960. Yet, in the light of the climate changes, many results from that work are not comparable with those of our times. The Interreg IV Italy-Austria "3PClim" project (where the three Ps stand for past, present and perspectives) was therefore set up three years ago with the aim of carrying out an exhaustive and homogenous climatological study to meet the requirements of the area including Tyrol, South Tyrol and Belluno region, thanks also to the new remote sensing techniques (satellites, radar, lightning recording) that pave the way to new kinds of climatological studies.

The study has also analysed the climate changes in the next decades.

The project, to which the provincial meteorological service and the homologous

Innsbruck and Arabba services took part, has drawn up a sort of climate map with data from 1981 to 2010, and has developed climate prospects from 2026 to 2055 and beyond.

SEASONAL SNOW ACCUMULATION ON THE STELVIO GLACIER 10 years of mesurements

A. Praolini, E. Meraldi, F. Berbenni

In the last ten years, snow scientists and forecasters from the Centro Nivometeorologico of ARPA Lombardia (CNM) have carried out measurements on the Stelvio Glacier (Sondrio) every summer season, particularly to find information about the snowcover stability in summer months, providing a set of data that is very useful for the drawing up of the snow and avalanche bulletin. All that has led to the acquisition of accurate measurements of snow cover depth on four main stations of the Stelvio Glacier at more than 3000 m of altitude.

The importance of snow as a tourist resource on the Stelvio Glacier is well known internationally, as since 1930 the glacier has been attracting in summer months countless skiers and tourists. Since the 1980-90s, the glacier has been used for training by skiers, snowboarders, Nordic skiers and sledge athletes from several associations, ski clubs and International federations. Data processing, carried out for statistical aims, with also climatological implications, underlines the degree of glacier health in terms of snow covering-melting in recurrent periods, often in close relation with winter seasons with more or less intense snowfalls, the climate trend of summer months or melting due to rainfalls.

Making the most of the accurate summer observations, CNM experts of ARPA Lombardia Bormio, who have also been monitoring several glaciers in Alta Valtellina for almost thirty years, in collaboration with Comitato Glaciologico Lombardo, though not having carried out any measurements about the ablation process on the Stelvio Glacier, have estimated that this basin, too, is being affected by a loss of ice thickness (25-30 m) and glacial mass that can be associated with what is taking place in parallel on the Monte Sobretta glacier in Valfurva, another glacier CNM experts have been monitoring in summer months, in particular using technically advanced working methods.