# WINTER EXTREME EVENTS – ROMANIAN CARPATHIAN AVALANCHES

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**ABSTRACT. –** The study presents a statistics of avalanche cases recorded in Romanian Carpathians over the years, most of them since February 2004, when the National Meteorological Administration program for snow and avalanches started, but also from Mountain Rescue Teams, various articles or works. The purpose of this paper is to analyze the meteorological context in which these phenomena occurred. Similar conditions in wich avalanches were triggered are also presented, as basis for future data comparison and work in avalanche risk estimation. Classical methods of meteorological study were used: the evolution of key meteorological parameters over the territory of our country, the barometric topographic maps from ground level and altitude (850 and 500 hPa level), that were taken from the archives of the National Administration of Meteorology, and the GFS model (www.wetter3.de). The study is part of Project Snowball, which aims to inventory the cases of avalanches previously known in our country and favorable conditions of release, to better estimate the risk of avalanches and minimize the effects it could have on the environment and people.
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## 1. INTRODUCTION

Most of the datas regarding avalanche releases have been gathered after February 2004, when the nivological program, regarding snow and avalanche risk, was started by the Romanian National Administration of Meteorology. The observational network included meteorological stations from Bucegi, Baiului and Făgăraş Mountains, with a high rate of turists, skiers and hikers. The recorded avalanches were mainly observed around the meteorological stations of Vârful Omu, Sinaia 1500, Predeal, Postăvaru and Bâlea-Lac.

The first avalanche known in the Romanian Carpathians is from april 1704 in the Ceahlău massif, that stroke the Sihăstria monastery and killed twenty monks (Bălan, 2001).

Avalanches happen everywhere in the mountain areas, sometimes blocking roads and railways, destroying the forest or killing people. Because a national program for avalanche studies does not exist, informations are far from being real. Except for Făgăraş and Bucegi, most of the informations gathered by now from the

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other massifs are about avalanches that killed people or caused high economic damages. With this disproportional informations, most avalanches have been recorded in Făgăraş Mountains (468 cases), followed by Bucegi, with 257 cases

This are the mountains where avalanche cases were recorded during the time: Apuseni, Baiului, Bucegi, Călimani, Căpăţânii, Caransebeş, Ceahlău, Cindrel, Ciucaş, Cozia, Făgăraş, Godeanu, Gutâi, Latoriţei, Leaota, Maramureşului, Lotrului, Meridionali, Parâng, Piatra Craiului, Postăvaru, Retezat, Rodnei, Şureanu, Ţarcu, Ţibleş, Vâlcan. Avalanches also occurred on Cernei, Jiului and Oltului Valleys, that are crossing the mountains from one region to another, causing roads or railways blocking. Besides that, avalanches were also recorded in different counties, such as: Alba, Argeş, Bihor, Caraş-Severin, Cluj, Gorj, Hunedoara, Maramureş and Mehedinţi, that have mountain areas; avalanches caused mainly road blocking, but did also affect houses or sometimes even killed people (http://www.antena3.ro; Milian N., Stăncescu M., 2012).

## 2. DATA AND METHODS

Before the beginning of the avalanche program in 2004, there were very few studies regarding avalanches in Romania.

The method used in this study is to identify the periods with recorded avalanches over the years (***, Bilanţul nivologic al sezonului de iarnă, 2004-2016; Gaspar R, Munteanu, S.A., 1968; Milian N. et al, 2010; Milian N., Stăncescu M., 2012; Moţoiu D. M., 2008; http://www.dinumititeanu.blogopedia) and then to analyse the specific synoptic conditions for each day with recorded avalanches, using sea-level pressure, 500 hPa geopotential and wind, 850 hPa temperature maps were analysed, using the NCEP/NCAR Reanalysis Project maps, available online (www.wetter3.de/archive).

After 2004, annual reports about avalanches were made by National Administration of Meteorology, as well as studies regarding specific synoptic conditions related to some cases. This kind of approaches has been used by several Avalanche Services worldwide (Fitzharris B.B, 1987; Hansen C., Underwood S.J, 2012; Höller P, 2009).

## 3. AVALANCHE STATISTIC

The recorded avalanches cover almost a century, though the first record we found is from the beginning of 18$^{th}$ century. As seen in Fig.1, there are very few informations about avalanches before 2004, all related to victims or high damages – less then 7 cases by year; there are large periods with (by now) no records. For the moment, there are 845 avalanche records, over all Romanian Carpathians. For some of them, the exact data is not known – just the year or year and month when the avalanche happened.

The situation is better reflected if we are representing the number of avalanches by decades – a huge raising in 2001-2010 (488 cases) and after 2011

until present (294 cases). As for the period after 2004, a higher avalanche activity was recorded in 2005, beside that year is usually about 40…50 recorded cases every year – (Fig.2) (Milian N. & al, 2006; Moţoiu D.M, 2008; ),.

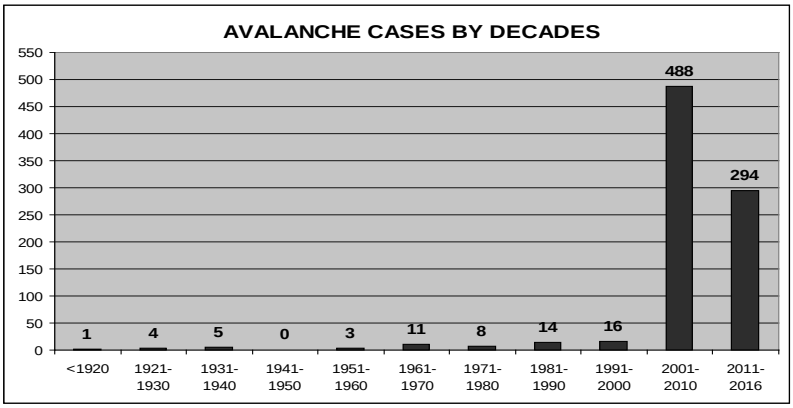


**Fig. 1.** ***Number of avalanche cases by decades, as known by now***

The recorded data showed that most of the avalanches happened during the month of march (27 %), followed by april (20.3 %), february (17.1 %), may (12.5 %), january (9.6 %), december (6.4 %), november (4.0 %) and october (2.3 %). Very few avalanches were recorded in june (0.7 %) and september (0.1 %). For july and august there is no case recorded – (Fig.3).

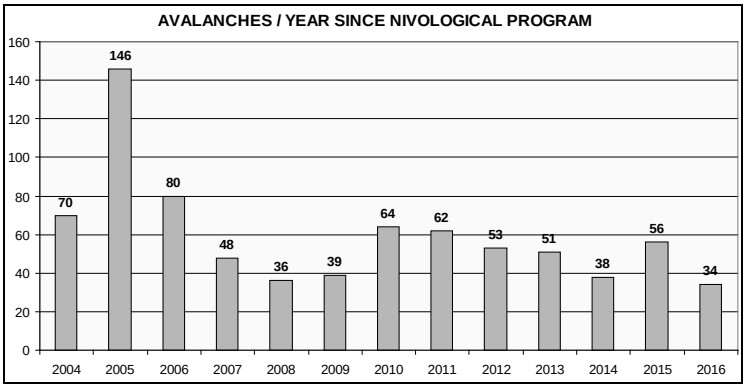


**Fig. 2.** ***Number of avalanche cases by every year after 2004***

Most of the avalanches happened during the spring season, 59,8%, 33,1% in winter, 6,4% in autumn and 0,7% in summer.

## 4. SYNOPTIC CONDITIONS

Regarding the baric systems that acted over our country during the days when avalanches happened, in 99 cases there was an anticyclone system, 283 cases

with ridges (from Azores or East-European High), 62 cases with anticyclone zone formed by the two highs, a contact between Azores High and Icelandic Low in 53 cases, Icelandic trough in 138 cases, 96 cases Mediterranean cyclones, 45 cyclonic area and 15 cases of barometric cole.

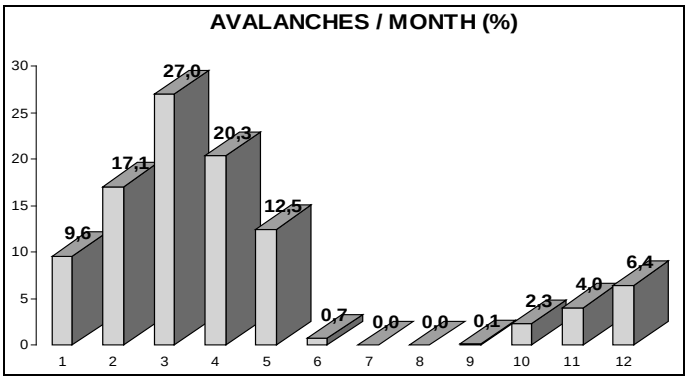


**Fig. 3.** ***Procent of avalanche cases by month***

Considering ground-pressure values, 318 avalanches occurred on high pressure conditions (ground pressure above 1020 mb), from wich 57 greater than 1030 mb and 16 greater than 1035 mb. For 204 cases, ground-pressure values were between 1015 to 1020 mb, and for 286 cases lower than 1015 mb (most of them, 138 cases, from 1010 to 1015 mb) – (Fig.4).

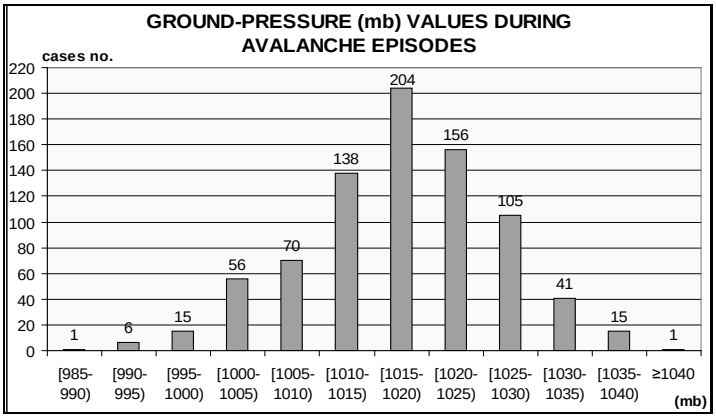


**Fig. 4.** ***Number of avalanche cases by sea-level pressure values***

Geopotential values on the 500 hPa level ranged from 516 to 588 damgp. Of these, 1 cases was lower than 520 damgp, 40 between 520 and 530 damgp, 62 between 530 and 540 damgp, 150 between 540 and 550 damgp, 227 between 550 and 560 damgp, 245 between 560 and 570 damgp, 69 between 570 and 580 damgp and 7 over 580 hPa – (Fig.5.a). As can be seen, most of avalanches (60%) occurred for relative high geopotential values, of 550 to 570 damgp.

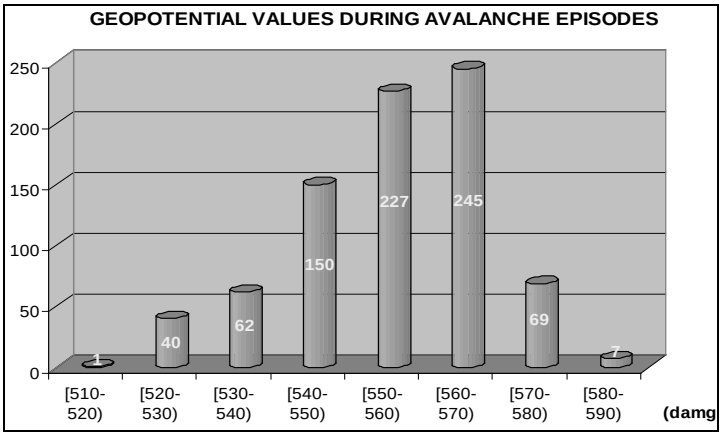


**Fig. 5.** ***Number of avalanche cases by 500 hPa level geopotential***

At this level, 339 cases happened when trough structures acted over the country, 201 were related to ridges, 136 cases to different contacts between altitude structures, 84 for westerly flows and 28 cases to nuclei or cut-off structures.

Wind direction at 500 hPa was from north in 7% of the cases, 2% north-east, 2 % east, 4 % south-east, 6 % south, 34 % south-west, 23 % west and 20 % north-west (Fig.6). It can be easily seen that most of avalanches happened while high altitude flow was mainly from west sector (south-west to north-west, 67%), all other direction being very poor represented. South-west flows are often associated with forward Icelandic trough positioning, often responsible for weather warming and strong winds.

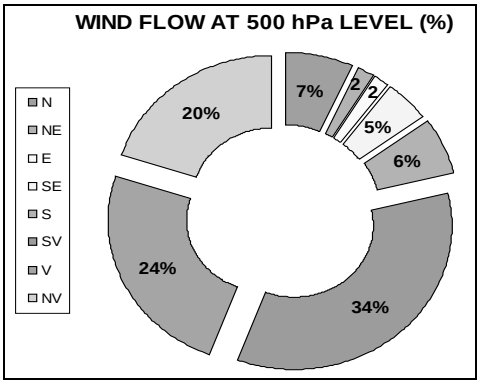


**Fig. 6.** ***Number of avalanche cases by 500 hPa flow***

As seen in Fig.7, 850 hPa level isotherm values were between -20 and -16 degrees in 4 cases, -15 and -11 degrees in 31 cases, -10 and -6 degrees in 117 case, between -5 and -2 degree in 138 cases, -1 to 1 degree in 106 cases; 2 to 5 degrees in 189 cases; 6 to 10 degrees in 183 cases; 11 to 15 degrees in 30 cases and more than 15 degrees in 2 case. Gathering the informations, we can say that most of

avalanches happened between +2 and +10 degrees (372 cases), that can be related to weather warming episodes, but the number of cases was also high for temperatures between -10 to +1 degree (361 cases), when most of important snowfalls are taking place.

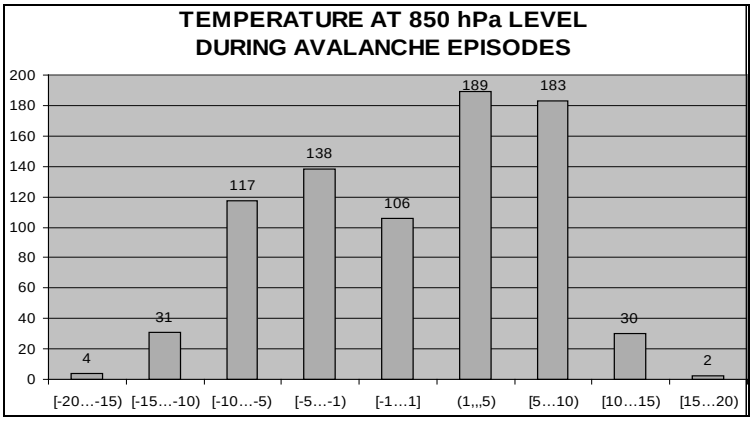


**Fig. 7.** ***Number of avalanche cases by 850 hPa level temperatures***

## 5. CONCLUSIONS

The large number of avalanche cases studied shows that this extreme phenomena occur under very different synoptic conditions, in all the Romanian Carpathians and during the whole winter, but mainly during february-april.

As known, avalanches do not happen only after heavy snowfall or increasing temperatures, but also depend on snow crystals transformations inside the layer, especially on the formation of faceted, unstable crystals inside. Thus, studies about snow stability, avalanche triggering conditions and endangered areas are highly needed. Because of the large number of analyzed cases, the study is very usefull, because it provides similar-like situations for avalanche prediction. Thus, it is a step forward for better avalanche risk estimations in dangerous areas, in order to avoid human life loss, but also to prevent massive accidents with significant economic damage for people and environment.

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