

## 2017-2018 WINTER - FAVORABLE AVALANCHE CONDITIONS IN SOUTHERN CARPATHIANS

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**ABSTRACT.** – The paper presents and analyzes the variations of the measured parameters at the meteorological stations, favoring the avalanches of the winter season 2017-2018 in the areas monitored by Romanian National Administration of Meteorology. The analyzed parameters, both meteorological and snow specific, are measured in daily observations and weekly measurements at Bâlea-Lac, Vârful-Omu, Sinaia and Predeal meteorological stations, since February 2004. Annual reports include studies about the evolution of avalanche risk during winters (\*\*\*, *Bilanțul nivologic al sezonului de iarnă*, 2011-2017). Every year, the favorable conditions leading to avalanche triggering were analyzed (Milian, 2015; Grecu C. & al. 2016; Milian, 2016; Reckerth & al, 2018). All measured and observed data, as well as are included in a database to study conditions favorable to avalanche triggering and its use to better estimate avalanche risk and mitigate its environmental and human impacts (Esteban P. & al. 2005). First snowfalls have fallen at 7 October 2017, forming a first snow layer, that melted days after. A new continuous snow layer was formed after 24 October 2017 at Vârful-Omu and at all other mountainous stations after 28 November. The snow has maintained in the upper areas of Bucegi and Făgăraș Mountains until 17 May 2018 at Bâlea-Lac and May 22, 2018 at Vârful-Omu. Avalanche triggering conditions were due most to high temperatures and/ or sudden temperature growth, and less to significant snowfalls and conditions occurring within the snow layer, resulting of unstable structures.

**Keywords:** avalanche, ground pressure, temperature, snowfall, Southern Carpathians

### 1. INTRODUCTION

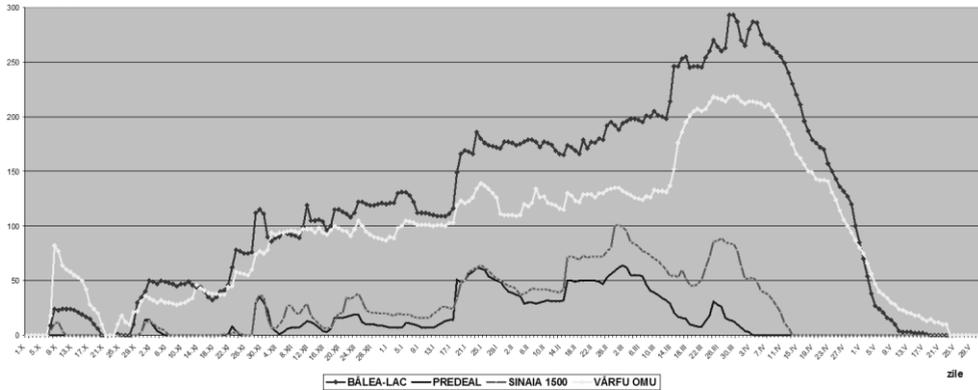
Nivological season 2017-2018 began on October 6, 2017 at all four stations that perform a nivological program. During the year 2018, 990 observations were made at the meteorological stations already included in the nivological program (Sinaia, Predeal, Vârful-Omu and Bâlea-Lac), twice daily, starting 1 January and 15 April in Predeal and Sinaia, 15 May at Bâlea-Lac and 31 May at Vârful-Omu. At these stations, 92 surveys and stratigraphic profiles of the snow layer were made. Last nivological information was issued on May 3. The newsletters were posted on the official site of the National Meteorological Administration and sent to: Dispatcher of the Ministry of Environment, Mountain Rescue Teams (Salvamont), prefectures,

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county councils in the monitored area, mass media.

Annual schedule of daily meteorological parameters show snow thickness variation, as well as alternation of colder with warmer periods, that favored partial snow melting and surface moisture, thus increasing the risk of triggering avalanches (Fig. 1).



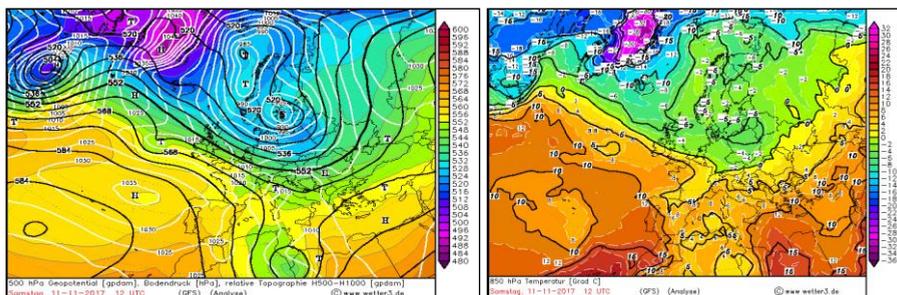
**Fig. 1. 2017-2018 winter season - daily meteorological parameters measured at the four meteorological stations with nivologic program**

Maximum snow thickness in the meteorological stations platform were recorded at Bâlea-Lac on 28 March, 2018 and had the value of 294 cm. At the other stations, the highest values were: 219 cm at Vârfulu-Omu (28-29.03.2018), 102 cm at Sinaia (28.02.2018) and 64 cm at Predeal (01.03.2018) (Fig.1).

## 2. SYNOPTIC CONDITIONS FOR AVALANCHE PERIODS

### 2.1. November 11 – 22, 2017

During the period, the Icelandic Trough was active over the country, except 14-17 November, when Azores High influenced our area; at 500 hpa, the associated Icelandic Trough was active most of the time (Fig. 2). At the level of 850 hPa, isotherm value ranged from 2 to 6 °C from 11 to 18 November, then decreased to -6...-4 °C until 21 November, increasing again on last day of the interval, to 1 °C.



**Fig. 2. 2017.11.11, at 12 UTC – NCEP numerical model – reanalysis. Ground-level pressure, relative topography, geopotential, 850 hPa temperature**

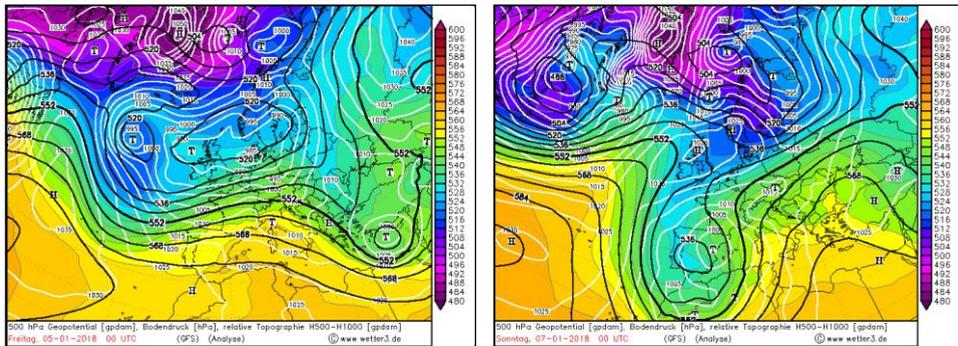
Maximum temperatures increased, becoming positive at altitudes of 2000 m - at the Bâlea-Lac meteorological station (0.4 ... 4.1 °C), and minimum ones also had high values (reaching 1.3 °C).

Even at 2500 m – Vârfulu-Omu meteorological station - maximum temperatures have reached values of 0 ... 1,2 °C for three consecutive days. Temperature values have also been high in the previous period, favouring snow wetting at the surface and triggering wet snow avalanches.

## 2.2. January 5 to 7, 2018

At the beginning, Icelandic Low was active over Romania, then, from January 6, Europe High advanced over our country, with correspondent structure on altitude, increasing ground pressure to 1020 hPa and geopotential values at 500 hPa from 552 to 568 dmgp. (Fig. 3).

Temperatures during the day increased to positive values even on higher altitude, for example 3,5 °C at Bâlea-Lac, where snow decreased from 131 to 118 cm. Melting surface avalanches happened every day.



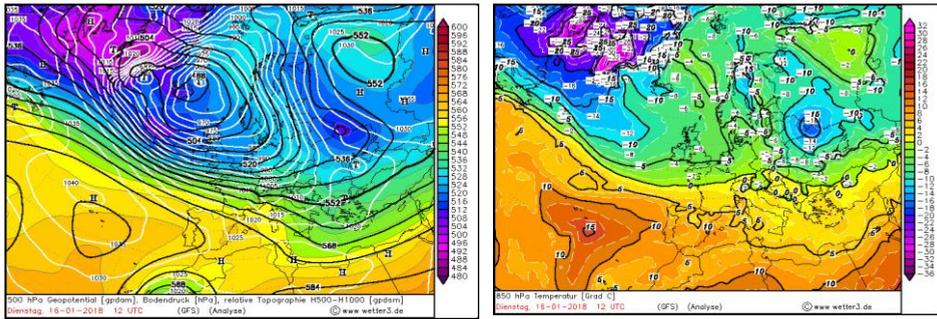
**Fig. 3. 2018.01.05 and 07, a 00 UTC – NCEP numerical model reanalysis. Ground-level pressure, relative topography, geopotential, 850 hPa temperature**

## 2.3. January 16 to 24, 2018

The period was dominated by widening of Icelandic Trough from 17 to 22 January, with ground pressure values of 1010 hPa and intrusion of East European High from 23 and 24 January. In middle troposphere, the associated Icelandic Trough persisted until the last day, when associated Azores Ridge gradually moved over Romania (Fig. 4).

The values of 850 hPa level isotherm highly increased from January 16 at 00 hour (-10 °C) to -5...-4 °C at noon and remained at that value until the end of the interval.

Temperatures were low, up to -13.4 °C at Bâlea-Lac and -17.3 at Vârfulu Omu. Snow layer increased from 103 to 139 cm at Vârfulu-Omu and from 111 to 186 cm at Bâlea-Lac. Several fresh, light snow avalanches were recorded.

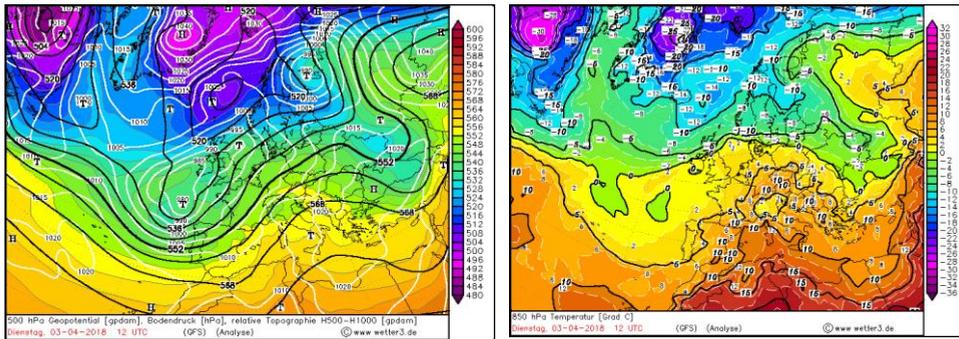


**Fig. 4. 2018.01.16, at 12 UTC – NCEP numerical model reanalysis.  
Ground-level pressure, relative topography, 500hPa geopotential, 850 hPa temperature**

#### 2.4. April 3-4, 2018

Ground pressure field was high, due to the Azores Ridge, with values of 1020...1025 hPa, and also on middle troposphere (up to 568 dmgp). Isotherm at 850 hPa level had positive values, from 5 to 10 °C (Fig. 5).

Maximum temperatures were positive at all meteorological stations. Snow melted from 287 to 275 cm at Bâlea-Lac, and melting avalanches were observed.



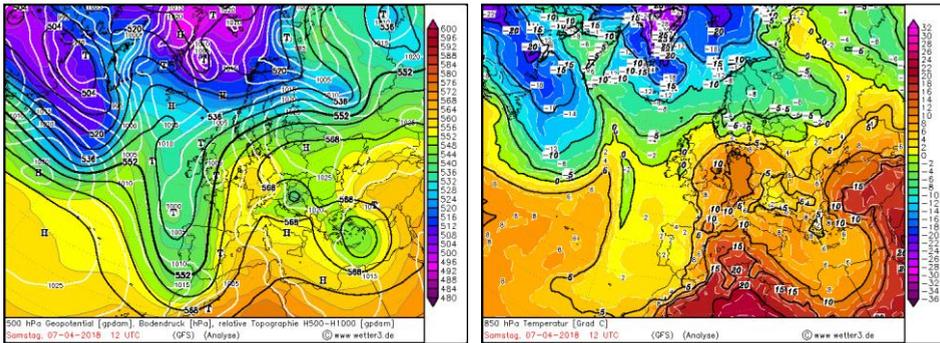
**Fig. 5. 2018.04.03, at 12 UTC – NCEP numerical model – reanalysis.  
Ground-level pressure, relative topography, geopotential, 850 hPa temperature**

#### 2.5. April 7 to 10, 2018

The period was characterized by the presence of the Icelandic Trough and advance of a Mediterranean Low to south and then east of the country.

Frontal systems were active in western Romania from March 22 to 27, together with Icelandic Low descent, then an occluded front over the country up to March 30. On middle troposphere, an associated Icelandic Trough was also active (Fig. 6).

Maximum temperatures were positive at all meteorological stations, even the high ones (over 2000 m). Snow melted from 266 to 253 cm at Bâlea-Lac, and from 211 to 193 cm at Vârfu-Omu. Daily melting avalanche occurred.

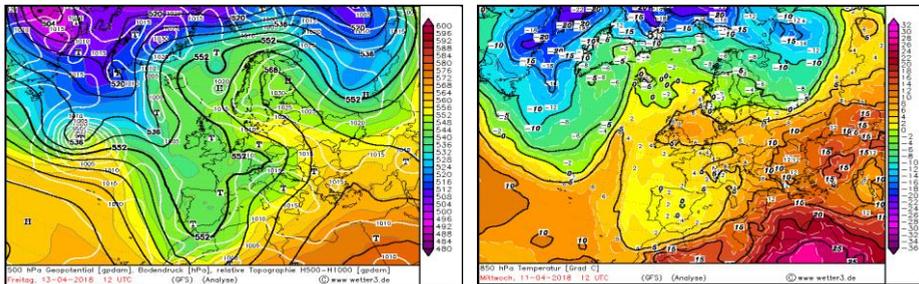


**Fig. 6. 2018.04.07 and 10, at 12 UTC – NCEP numerical model – reanalysis. Ground-level pressure, relative topography, geopotential, 850 hPa temperature**

### 2.6. April 13 to 18, 2018

Until the end of this period, the Azores Ridge persisted over the country, with ground pressure field values from 1025 to 1015 hPa on last day. In the middle troposphere, the associated Azores Ridge also persisted over the country, with geopotential values around 568 dmgp. In lower troposphere, the 850 hPa isotherm had high values, of 10...12 °C, than fell to 8 °C (on April 18) (Fig. 7).

Daytime temperatures recorded at all meteorological stations were positive, reaching 10.6 °C at Bâlea-Lac, and 8.2 °C at Vârful-Omu. Night temperatures were negative at altitudes above 2000 m and positive at lower altitudes. Snow melted fast, from 230 to 176 cm at Bâlea-Lac and from 175 to 147 cm at Vârful-Omu. Melting avalanches were recorded almost every day.



**Fig. 7. 2018.04.13, at 12 UTC – NCEP numerical model – reanalysis. Ground-level pressure, relative topography, geopotential, 850 hPa temperature**

### 3. CONCLUSIONS

Avalanches during 2017-2018 winter occurred under different synoptic conditions and in every month. Important snowfall, sudden increasing temperatures and southern winds were the most common avalanche triggering conditions, but also snow crystals transformations within the layer, especially the presence of faceted, unstable crystals inside. Important snowfalls, sudden warming and wind intensification from southern

sector were predicted in daily meteorological bulletins (\*\*\*, *Buletinul nivometeorologic*), while crystal transformations were predicted by specific software.

Because of the variety of conditions that can lead to instability of snow, every risk situations should be studied, in order to create a pattern of avalanche danger (Green et al. 2006), as well as a climatology of major avalanche winters (Fitzharris B.B., 1987). New observations points all over Carpathian Mountains will increase the data for avalanche risk estimations in the affected areas, in order to prevent and avoid any human life loss, massive accidents with significant economic damage.

From the six studied periods, four were under the effect of Icelandic Depression, and only two of the Azores Ridge.

During 2017-2018 winter, most of the avalanches happened on a low-pressure system at ground levels, associated with a trough in higher altitudes, most because of high thermal values and transformations that occur within the snow, leading to unstable structures and less in case of significant snowfall.

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