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FAVORABLE CONDITIONS FOR AVALANCHE TRIGGERING DURING 2018-2019 WINTER

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ABSTRACT. – The paper presents and analyzes the variations of the meteorological and specific snow parameters, which favored avalanches occurrence during 2018-2019 winter, in the area monitored by the National Administration of Meteorology. The analyzed parameters are measured by daily observations and weekly measurements at the weather stations Bâlea-Lac, Omu Peak, Sinaia and Predeal, Parâng, Țarcu, Semenic, Vlădeasa, Iezer, Călimani, Ceahlău, in order to use them for a better avalanche risk estimation and the diminution of their effects on the environment and people. The favorable conditions for triggering the avalanches were due to the significant snowfall, high temperature values or their sudden increase, as well as the transformations that take place inside the snow layer, when unstable structures are formed.

Keywords: avalanche, ground pressure, temperature, snowfall

1. INTRODUCTION

Nivological season 2018-2019 season started on November 15, 2018 at all eleven stations within nivological program; Bâlea-Lac, Omu Peak, Sinaia and Predeal, Parâng, Țarcu, Semenic, Vlădeasa, Iezer, Călimani, Ceahlău.

During 2019, a total of 2948 observations were made, starting from January 1 and until April 30 (in Predeal, Sinaia, Parang, Iezer, Vlădeasa, Semenic), May 15 (in Călimani, Ceahlau Toaca), May 31 (Țarcu, Bâlea-Lac, Omu Peak). Also, 211 surveys and stratigraphic profiles of the snow layer have been performed.

Based on the collected data, daily avalanche risk bulletins were issued and posted on the official site of the National Meteorological Administration and sent to: Dispatcher of the Ministry of Environment, Mountain Rescue Teams (Salvamont), prefectures, county councils in the monitored area, mass media.

Maximum snow thickness in the meteorological stations platform was recorded at Bâlea-Lac on the date of February 13, 2019 and had the value of 300 cm. At the other meteorological stations, the highest measured values were of: 174 at Țarcu Peak (12 and 13.02.2019), 146 cm at the Omu Peak (20.04.2018), 127 cm at Sinaia (30.01 and 01.02.2019), 115 cm at Călimani (23.02.2019), 111 cm at Semenic (24 and 25.02.2019), 102 cm at Parâng (31.01.2019), 92 cm at Ceahlău (25.01.2019), 84 cm at Vlădeasa 1800 (15.01.2019) and 63 cm at Predeal (15.02.2019) (Fig.1).

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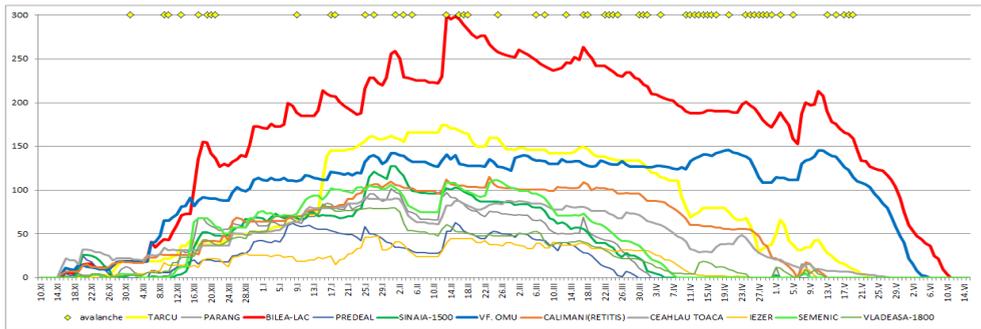


Fig. 1. 2018-2019 winter season - Snow layer variation and days with avalanche records at all the meteorological stations within nivological program

Annual graphics of daily meteorological parameters show snow thickness variation and amount of precipitation, with important snow accumulation, as well as alternation of colder with warmer periods, favoring snow melting and surface moisture, thus increasing the risk of triggering avalanches (Fig. 2-4).

At Bâlea-Lac, several avalanches were recorded, most of them during the periods: 09-21.12.2018, 17-18.01.2019, 25-31.01.2019, 16-25.02.2019 and 13-22.03.2019 (Fig. 2).

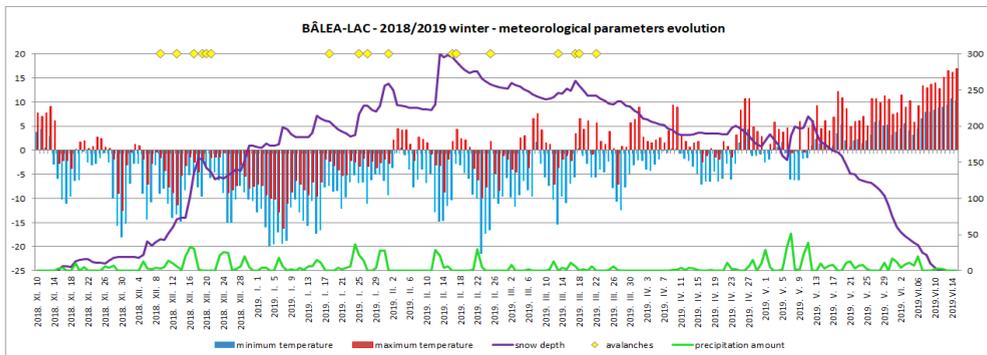


Fig. 2. 2018-2019 winter season - daily meteorological parameters measured at Bâlea-Lac meteorological station

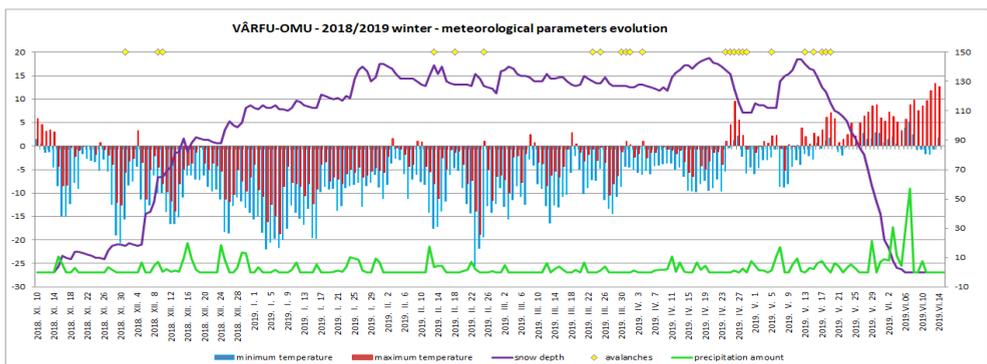


Fig. 3. 2018-2019 winter season - daily meteorological parameters measured at Vârful Omu meteorological station

At Vârfu-Omu meteorological stations, avalanches occurred mostly during the following periods: 13-20.02.2019, 23.03-03.04.2019, 24-29.04.2019, 13-19.05.2019 (Fig. 3) and at Iezer meteorological station avalanches were recorded during 06-08.03.2019, 22-24.03.2019, 10-17.04.2019 (Fig. 4)

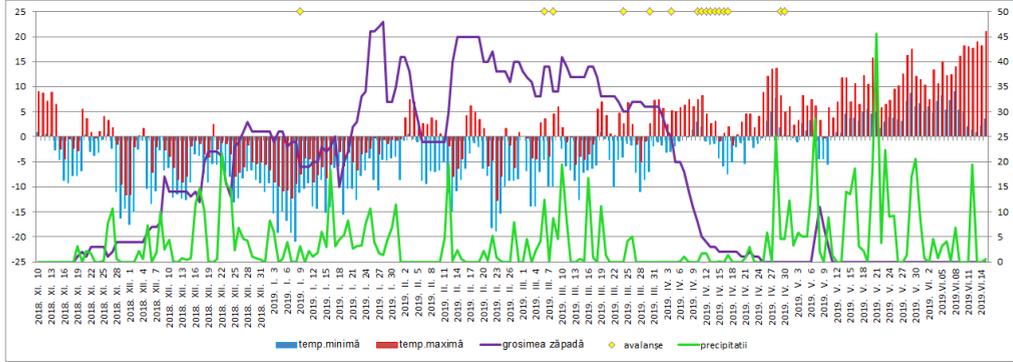


Fig. 4. 2018-2019 winter season - daily meteorological parameters measured at Iezer meteorological station

2. SYNOPTIC CONDITIONS FOR AVALANCHE PERIODS

2.1. January 13 to 17, 2019

During the period, the Icelandic Trough High influenced our area, while Azores High was approaching over the country. At 500 hpa, the associated Icelandic Trough was already active (Fig. 5). At the level of 850 hPa, isotherm value ranged from -10 in January 13 to 0 degrees in January 17 (Fig. 5).

Avalanches were reported most on Bâlea-Lac, where snow depth increased from 185 to 214 cm (from January 13 to 15). Maximum and minimum temperatures were low (-17,6 and 6,6 in January 16) until January 17, when they increased to -7,7 and -1,8 degrees.

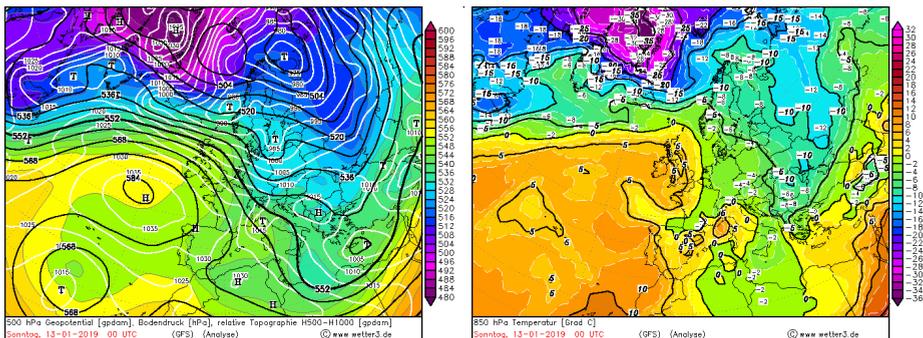
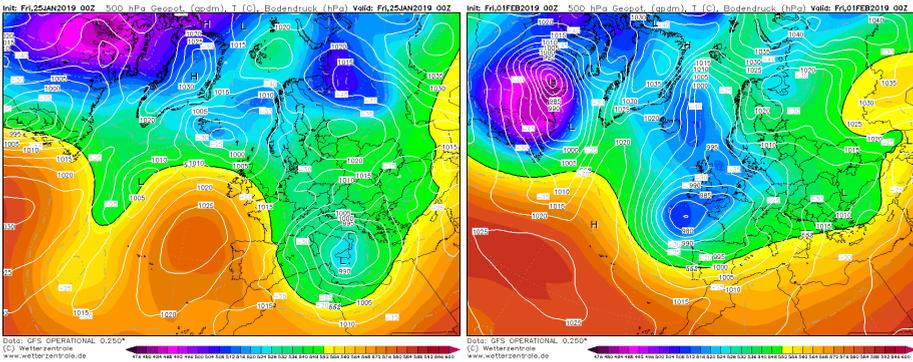


Fig. 5. 2019.01.13, at 00 UTC – NCEP numerical model – reanalysis. Ground-level pressure, absolute topography and 500hPa geopotential and 850 hPa geopotential and temperature

2.2. January 25 to February 01, 2019

All the period, the Icelandic Low was active over Romania, with correspondent structure in altitude, with ground pressure values around 1005-1010 mb and geopotential values at 500 hPa of 540 to 548 dmgp (Fig. 6). At the level of 850 hPa, isotherm value ranged from -5 to 4 degrees on January 28 and 29, then back to 0 degrees.

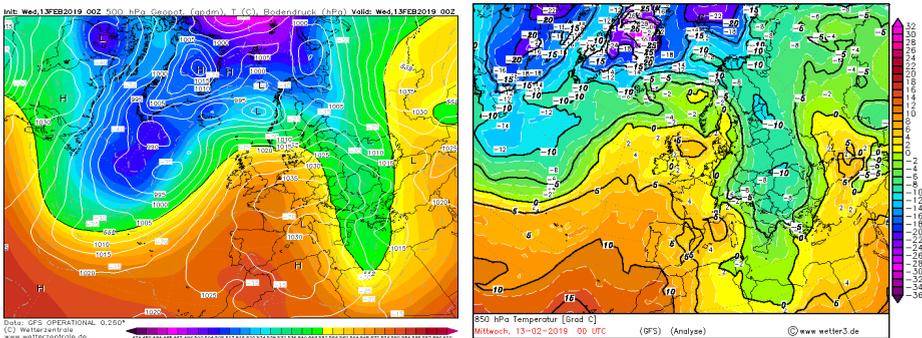
Though temperatures did not have significant variations during this period, the important amount of snow that felt at Bâlea-Lac (40 cm, from January 24 to 26 and 39 cm from January 29 to February 1), offered the optimal conditions for avalanche release.



**Fig. 6. 2019.01.25 and 02.01, at 00 UTC – NCEP numerical model – reanalysis.
Ground-level pressure, absolute topography and 500hPa geopotential**

2.3. February 13 to 25, 2019

The period was dominated by the Azores High, with ground pressure values up to 1040 mb, with associated altitude structure at 500 hPa. During February 23 and 24, an Icelandic Trough, with low geopotential values, down to 532 dmgp and very cold air (-35 degrees) passed over the country (Fig. 7).



**Fig. 7. 2019.02.13, at 00 UTC – NCEP numerical model reanalysis.
Ground-level pressure relative topography, 500hPa geopotential;
850 hPa geopotential and temperature**

The values of 850 hPa level isotherm increased from February 13 (-10 degrees) to 4 degrees on February 17 (Fig. 7) and remained at that value until February 20. Then, with the associated trough structure and cold air intrusion, decreased to -15 degrees until the end of the interval.

Again, at Bâlea-Lac felt a huge amount of snow – 70 cm in one day, reaching the highest snow value for this winter (300 cm in February 13). With the increasing temperatures in the next days, reaching positive values, several avalanches occurred in the area (Fig. 7). Though the amount of new snow was considerable lower, several avalanches occurred in Bucegi Mountains, near Vârful Omu meteorological station.

2.4. March 13 to 18, 2019

While ground pressure field was high at the beginning of the interval, due to the Azores Ridge (ground pressure values around 1020 mb), then, with the intrusion of the Icelandic Trough, they decreased to 1015 mb. On middle troposphere, already acted the Icelandic Trough, with geopotential values around 540 dmgp and temperatures from -30 to -25 degrees. Isotherm at 850 hPa level values around -5 degrees, increasing to the end up to 8 degrees (Fig. 8).

A small amount of fresh snow felt at the beginning of the interval, when low temperatures were recorded, The, temperatures increased, up to 6,5 degrees in March 18, and several melting avalanches occurred, especially in Făgăraș Mountains, at Bâlea-Lac.

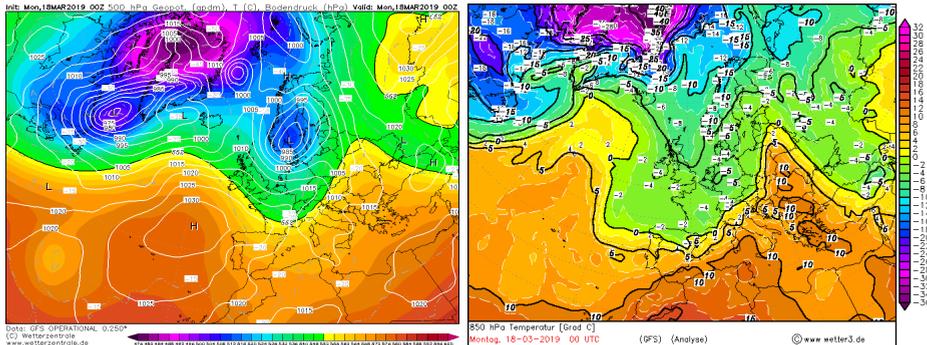


Fig. 8. 2019.03.18, at 00 UTC – NCEP numerical model – reanalysis. Ground-level pressure, absolute topography and 500hPa geopotential

2.5. March 22 to April 04, 2019

The period was characterized by the presence of the Azores High, with ground pressure values of 1025-1030 mb and associated altitude structure at 500 hPa, where geopotential values decreased from 572 to 560 dmgp (Fig. 9). The values of 850 hPa level isotherm varied from 0 to 6 degrees (in April 01) – (Fig. 9).

Maximum temperatures were mostly positive at meteorological stations from altitudes up to 2100 m, but remain mostly negative at Vârful-Omu (2504 m). Though

around 0 degrees, due to the insolation, several melting avalanches occurred also in the Vârfulu-Omu meteorological station area, as well at Bâlea-Lac and Iezer stations.

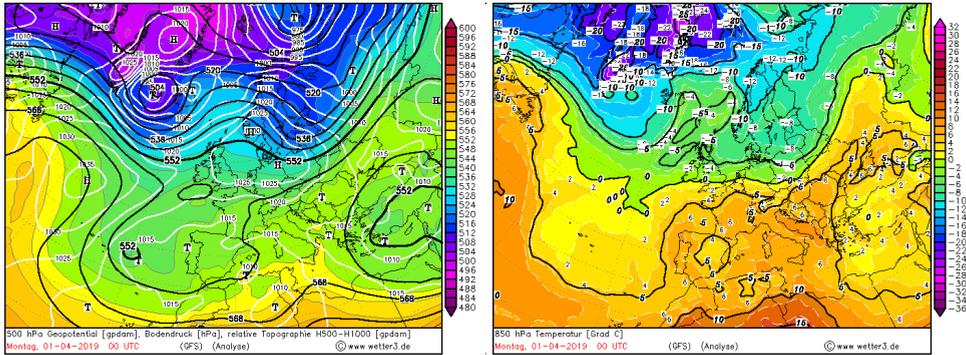


Fig. 9. 2019.04. 01, at 00 UTC – NCEP numerical model – reanalysis.
Ground-level pressure, absolute topography and 500hPa geopotential; 850 hPa geopotential and temperature

2.6. April 10 to 17, 2019

Up to April 15, a low-pressure ground field, with values of 1010 to 1015 mb, persisted over the country, with correspondent low geopotential of 548 to 552 hPa in the middle troposphere. From April 15 to 17, Scandinavian Ridge descended over the area, ground pressure increased up to 1025 mb and geopotential values at 500 hPa up to 568 dmgp. In lower troposphere, the 850 hPa isotherm decreased from 6 (in April 10) to 0 degrees (April 17) (Fig.10).

Several melting avalanches were recorded around at Iezer station, were daytime temperatures were positive, reaching up to 8.3 degrees. Some of the night temperatures were also positive.

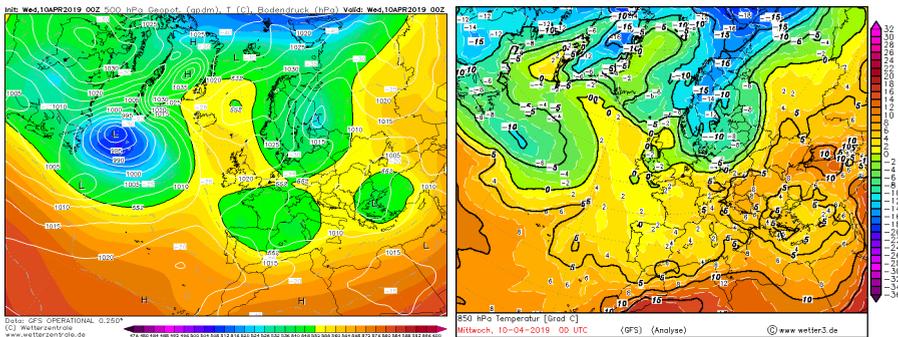
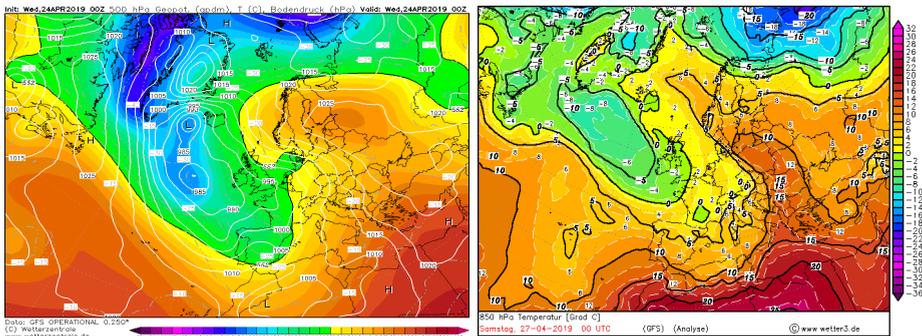


Fig. 10. 2019.04.10, at 00 UTC – NCEP numerical model – reanalysis.
Ground-level pressure, absolute topography and 500hPa geopotential; 850 hPa geopotential and temperature

2.7. April 24 to May 19, 2019

Until April 28, the Azores Ridge persisted over the country, with ground pressure field values around 1025 mb and associated middle level structure; then, up to the end of the period, ground pressure decreased to 1005 mb, due to the intrusion of a northern trough. In lower troposphere, the 850 hPa isotherm had high values, from 8 degrees in April 24 to 12 degrees in April 27, than fell to 4 degrees (on May 02) and remained around 4 ... 6 degrees until the end (Fig. 11).

With positive daytime temperatures recorded at all meteorological stations, reaching 10.7 degrees at Bâlea-Lac, 9,5 degrees at Vârful Omu and 13,7 degrees at Iezer, snow melting and decreasing of height continued, as well as melting avalanches occurrence, that were recorded almost every day at Vârful-Omu meteorological station.



**Fig. 11. 2019.04.27, at 00 UTC – NCEP numerical model – reanalysis.
Ground-level pressure, absolute topography and 500hPa geopotential;
850 hPa geopotential and temperature**

3. CONCLUSIONS

In Romania, snow measurements and avalanche monitoring are made only by the National Administration of Meteorology. Though almost every winter avalanche synoptic conditions were studied since the beginning of nivological program, for Făgăraș and Bucegi Mountains, the extended measurements network offered a great opportunity to begin snow and avalanche studies all around the Carpathians.

As in the other winter seasons (Milian, 2016, 2019; Grecu, 2017), during 2018-2019, avalanches occurred all over the mountains, under different synoptic conditions and in every month. Most common avalanche triggering conditions remained important snowfall, fast increasing and positive temperatures.

With the extending of observational network at most of the mountain meteorological stations, snow and avalanche survey and avalanche risk estimation have made important steps forward, in order to prevent and avoid any human life loss, massive accidents with significant economic damage.

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