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THE RISK OF BLIZZARD APPEARING IN BÂRLAD PLATEAU DURING 1961–2010

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Abstract – The risk of blizzard appearing in Bârlad Plateau during 1961 – 2010. The wind has the highest monthly average speeds regardless of direction in the cold season, including winter (XII-II), when the thermo - baric contrast is the largest due to alternating of cold and heat waves, as well and in the spring months March-April, when the air movement direction is changing from east to west. In the past two decades amid global climate change, it appears that *the transition from winter to spring is faster as a result of higher dynamic that has atmosphere has from the end of February till early March*. On the other hand, the frequency of wind classes with high speeds fell sharply in January, so we can say that *violent blizzards occurred less frequently in the recent decades* to the seventh decade of the 20th century.

Key words: non-periodic variability, barometric centers, blizzard coupling

1. INTRODUCTION

Wind speed is influenced by relief and the thermal stratification of the air, which could increase or decrease it.

During the year, wind speeds present a great unevenness. **The highest monthly rates** are observed sometimes **in the cold season**, when the thermo - baric contrast is the largest, but their value is similar to the annual one.

It is worth mentioning that *seasonal changes of general air circulation causes some changes in wind speed*, even in winter. Thus, the persistence of anticyclone time during **winter**, make the valleys and the micro-depressions persist with calm weather, so the wind is absent. This situation is not permanent.

All these variations in wind speed depends on the peculiarities of climate and **local factors** influences. The phenomenon is explained by the seasonal distribution of atmospheric temperatures and pressures at surface. In **winter**, the **temperature contrasts between land and water**, and therefore **barometric gradients are higher than in summer**, as a result **wind speed will be higher**.

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Between the components of Bârlad Plateau's active surface, relief is the most important driver of climate and topoclimates, which is imposed by some fundamental characteristics, namely: altitude, shape, slope, fragmentation, exposition, the role of orographic barrier etc.

Of course, the most important characteristic is the **altitude** which determines the natural setting of the climate, and the setting of all other components of the environment (vegetation, soil, living things, water resources, and even human settlements and human activities).

Plateau is fragmented by Bârlad River's tributaries, which have the same orientation as the peaks. The **north-west - south-east orientation** of the Bârlad Valley (Figure 1) determines the most obvious air channeling, so the average values of wind speed and frequency are influenced by this genetic climate factor.

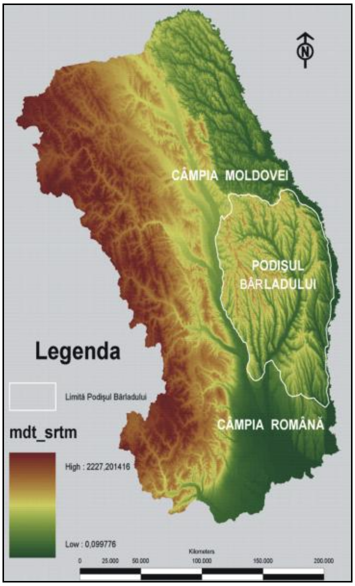


Figure 1. Limit and position of Bârlad Plateau

2. DATA AND METHODS

To achieve this works and to highlight the conclusions on the frequency, spatial-temporal distribution and intensity of the blizzard phenomenon on the territory of Bârlad Plateau were used several methods of calculation, both classical and modern, including linear trend and appearance frequency.

They were calculated and interpreted the basic climatic indicators: **averages** (monthly, annual and multi-annual) **probabilities** and were established **annual risk periods**. Also, were highlighted the damages made by blizzard phenomenon. There were presented the measures to prevent and combat the negative effects of these dangerous phenomena.

3. RESULTS AND DISCUSSION

3.1. Blizzard – general considerations and genesis

The blizzard is a common phenomenon for Romania's Extra-Carpathian regions, which occurs almost every year and has the highest frequency of appearance in January. **The strongest blizzards are the coupling ones,** but from the results obtained, **it can be said that the intensity and frequency of blizzards appearance has been decreasing in the last few decades.**

These changes can be attributed to barometric centers' distribution and to temperature anomalies in the cold season. On the one hand, **continental anticyclones,** which dynamically develop and thermally intensify by supercooling on the soil surface no longer have a special expansion in the central-eastern Europe and therefore the barometric and thermic gradients are not so great in blizzard situations. On the other hand, in the absence of an intense barometric jam in the Central-Eastern Europe, the cyclones arrived in the Black Sea, more rarely in a retrograde movement towards north-eastern Romania.

Therefore, as we shall see, in the Bârlad Plateau the **frequency of blizzard phenomenon appearance was clearly declining in recent years.**

The blizzard is an complex atmospheric phenomenon, specific to the lower troposphere, where snow falls or is swept away strongly by the wind, so visibility strongly decreases, making snow appreciation, while it's scattering is quite impossible (Țâştea et al., 1965).

For the temperate and cold areas, blizzard is the winter's atmospheric phenomenon with the most serious consequences, with great potential for disaster. It acts, both through the mechanical force of the wind, which can break tree branches, air wires, etc., but especially through shattered snow in open spaces and its accumulation in sheltered places where its thickness reaches sometimes several meters, producing serious difficulties to road and railway transport, as well as civil constructions and animal shelters. On the other hand, shattered snow on extensive agricultural terrains deprive winter crops of their natural protective layer that protect them from frost and reduces moisture needed for spring vegetative phase.

Bălescu and Beşleagă (1962) **define a blizzard as a phenomenon in the course of which, due to snow heavily disturbed at the ground, the sky becomes invisible and it cannot be distinguished if the snow falls from the clouds or is blown away by the wind.** So blizzard can be assimilated to strong wind intensification that blows away snow that is associated or not, and also to snow … on the ground.

Snow transport at height, is *a set of snow particles raised by the wind from the ground surface to a height, thus reducing vertical and horizontal visibility*. When the phenomenon is violent, it is practically not possible to determine if it is only about blowing snow on the ground or at the same time it is snow too (general blizzard) (*Clima României, 2008*).

Genesis. Result of the interaction between the air circulation particulations over the European continent and the characteristics of Romania's land area, this phenomenon occurs in certain synoptic situations specific to our territory, which result from the coupling of two barometric European centers - namely, the Eastern European, the Azores or the Scandinavian Anticyclones, with a Mediterranean perturbation – at the contact between them creating large thermo-baric gradients. Thus, in horizontal plan appear barometric and thermal marked gradients.

The strongest blizzards are those that arise while over the Central and Eastern Europe operates and develops an **anticyclone belt**, caused by the advance of anticyclone ridges, and above the Mediterranean Sea remain a constant cyclogenetic activity.Anticyclone belt is usually formed between the ridge of an East European anticyclone that reaches to unite across Central Europe with a ridge of the Azores Anticyclone; sometimes, anticyclone belt can be replaced by the presence of more anticyclones acting alone (Azores, Scandinavian or Eastern European Anticyclone) and extending through one dorsal over Romania, entering the coupling cyclones over the Mediterranean Sea or Black Sea. (Figure 2)

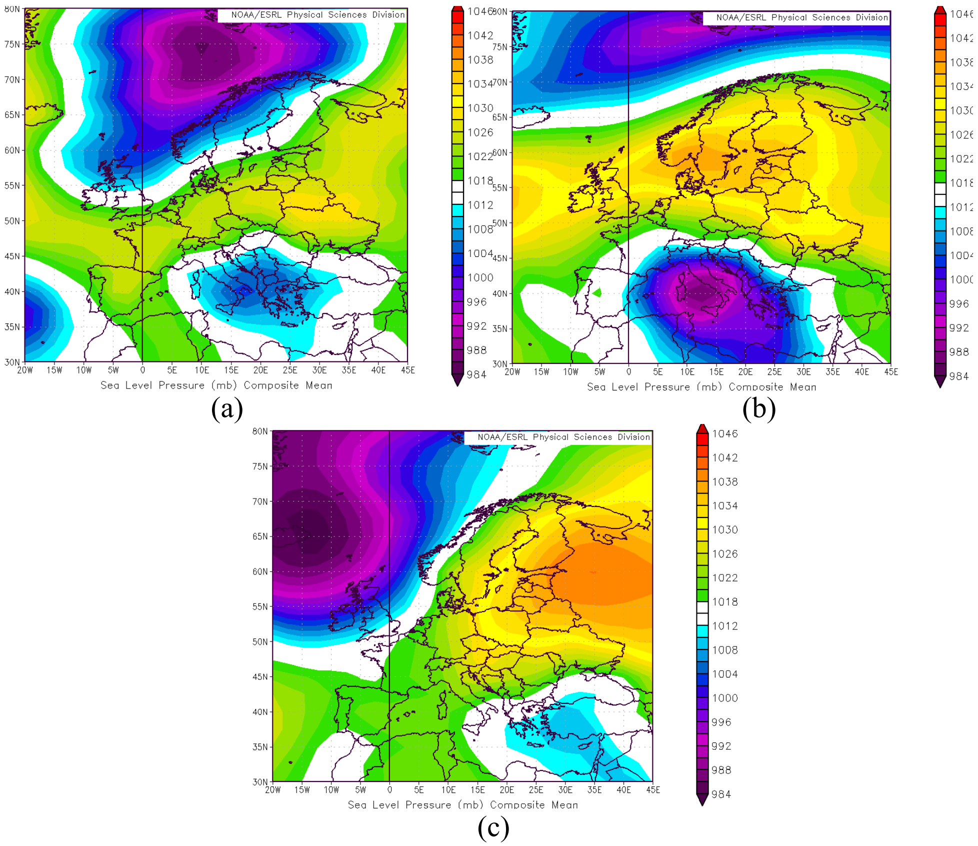


Figure. 2. Baric types generating blizzard in Romania (a, b, c) after Bălescu, Beşleagă, 1962

Besides synoptic causes **a significant role in the genesis of the blizzard returns peculiarities active surface structure and particularly the presence and shape of the Romanian Carpathians**, they largely acting nuances climate of our country. How blizzards occur at the close contact between the two types of air masses with different physical characteristics, facing brutal only in the lower layers of the troposphere, the role of orographic dam appears even more evident.

3.2. Average date of the first and last day and the average length of possible average interval with blizzard

The average date of the first blizzards is for the analyzed region in **December**, and the average date **of the last blizzard in February**. The blizzard phenomenon appearance differ from year to year. There have been years when the first blizzard occurred in late November and the last blizzard was in April.

This is the interval between the two average dates of appearance and disappearance of blizzards; for the Bârlad Plateau this interval ranges between the average date of the first blizzard (last decade of December) and the average date of the last blizzard (last decade of February), which is about 70-80 days.

3.3. Monthly and annual average number of days with blizzard

The average annual number of days with blizzard is 1-3 days on most of the Bârlad Plateau; the phenomenon is more common in Bârlad (2,52 days) and Vaslui (2,36 days) due to wind channeling on the Bârlad Corridor.

Apart from the actual days with blizzard, in Bârlad Plateau can be observed days with snow transport generated by a Crivăț.

The average annual number of days with snow transport is 5 ... 7 days, the most numerous being also at Bârlad (7,76 days) for the same reasons mentioned above, followed by Vaslui (7,14 days).

The average monthly number of days with blizzard is subunitary at most stations, which occurs on average 1 day in January (Table 1). In fact, **January** is the month that recorded the highest average monthly number of days with blizzard and all the other stations, but is subunitary (Table 1).

The average monthly number of days with snow transport reaches the largest values also in **January** at all stations, but most of them appear at Negreşti (3 days), Vaslui (2,76 days) and Bârlad (2,56 days).

Table. 1. Monthly and annual average number of days with blizzard and snow transport at soil in Bârlad Plateau (1961–2010)

Month	Bârlad		Vaslui		Negreşti		Huşi	
	Blizzard	**Transport**	**Blizzard**	**Transport**	**Blizzard**	**Transport**	**Blizzard**	**Transport**
October	0,00	0,02	0,00	0,00	0,00	0,00	0,00	0,00
November	0,16	0,54	0,14	0,32	0,18	0,50	0,11	0,37
December	0,30	1,34	0,32	0,96	0,07	1,07	0,26	0,53
January	1,00	2,56	0,94	2,76	0,57	3,00	0,87	2,13
February	0,80	2,42	0,66	2,14	0,36	2,82	0,74	1,79
March	0,26	0,88	0,24	0,96	0,18	1,07	0,21	1,00
April	0,00	0,00	0,06	0,00	0,02	0,02	0,00	0,00
Average annual no.	**2,52**	7,76	**2,36**	7,14	**1,39**	8,48	**2,19**	5,82

So, ***January is the month with the most days with blizzard and snow transport.***

The largest amounts of snow fall in the southern and south-western part of the plateau, and ***the highest wind speeds*** are recorded south of Tecuci, due to the reduction of the shelter role of the surface active.

By heavy snowfall and strong winds, blizzard causes major disruption to car traffic, blocking of roads, disruption of electricity and many places remain isolated for days.

Despite the fact that blizzards' annual frequency is known for each region and that the prevention of these atmospheric risk phenomena do not present a problem too difficult for meteorology, blizzard continues to produce every year numerous damage and even fatalities.

3.4. Maximum monthly and annual number of days with blizzard

The maximum number of days per month with blizzard at most stations from Bârlad Plateau was recorded in ***January and February***. The maximum number of days per month with blizzard was 10 at Huşi in February 1969, 9 days at Negreşti in January 1966, 9 days at Bârlad in February 1969, 7 days at Tecuci in January 1966 and 6 days at Vaslui in January 1963. So ***the highest number of days with blizzard*** was recorded at all stations in the Bârlad Plateau ***in the winters of the 6th decade of the last century.***The maximum number of days per year with blizzard was recorded in the winter of 1968 - 1969, when were recorded 22 days with blizzard at Huşi: 9 days in January, 10 days in February and 3 days in March.

3.5. Non-periodic variability and evolution trend of monthly number of days with blizzard

The number of days with blizzard in the last 5 decades has been declining in all winter months (Figure 3).

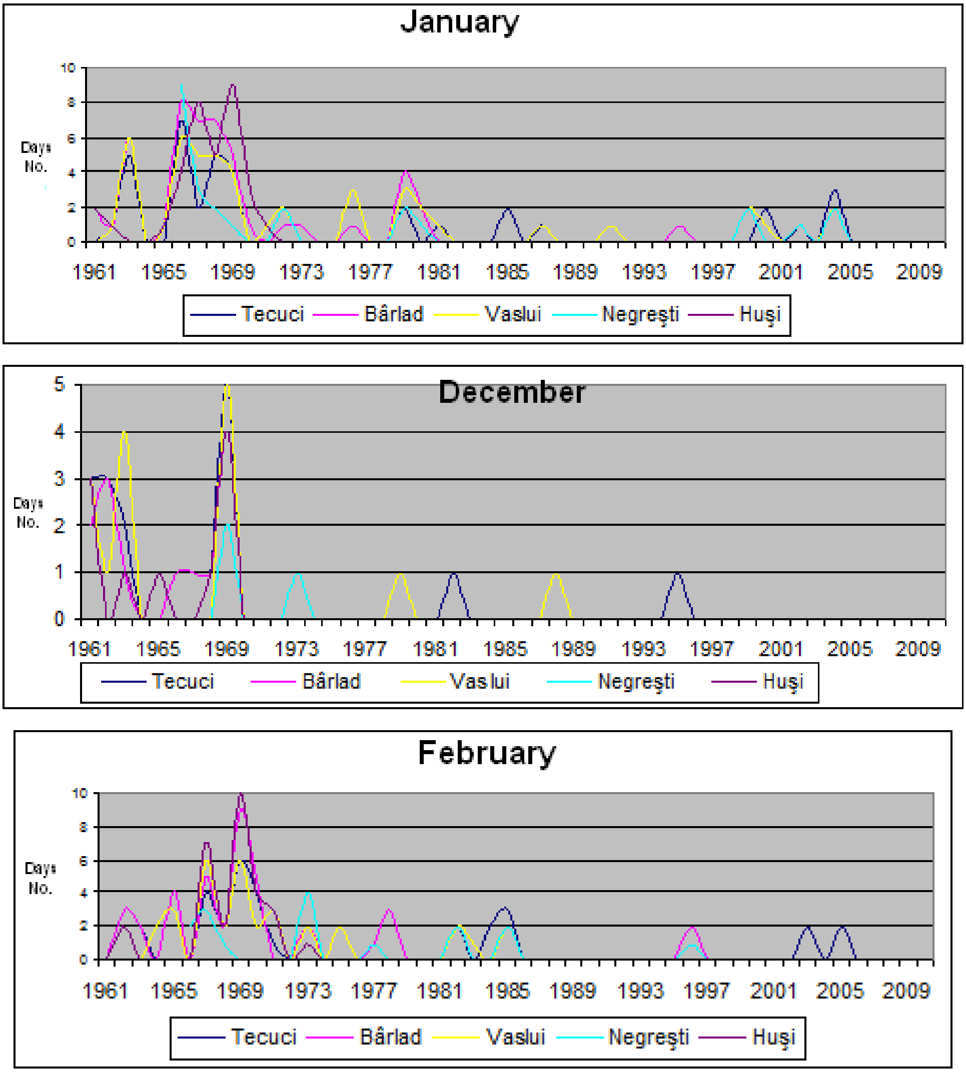


Figure 3 Non-periodic variability and evolution trend of the average number of days with blizzard in the winter months in Bârlad Plateau (1961–2010).

This downward trend in the number of days with blizzard is suggested by the changes of the baric atmospheric action centers in the last decades (Figure 4).

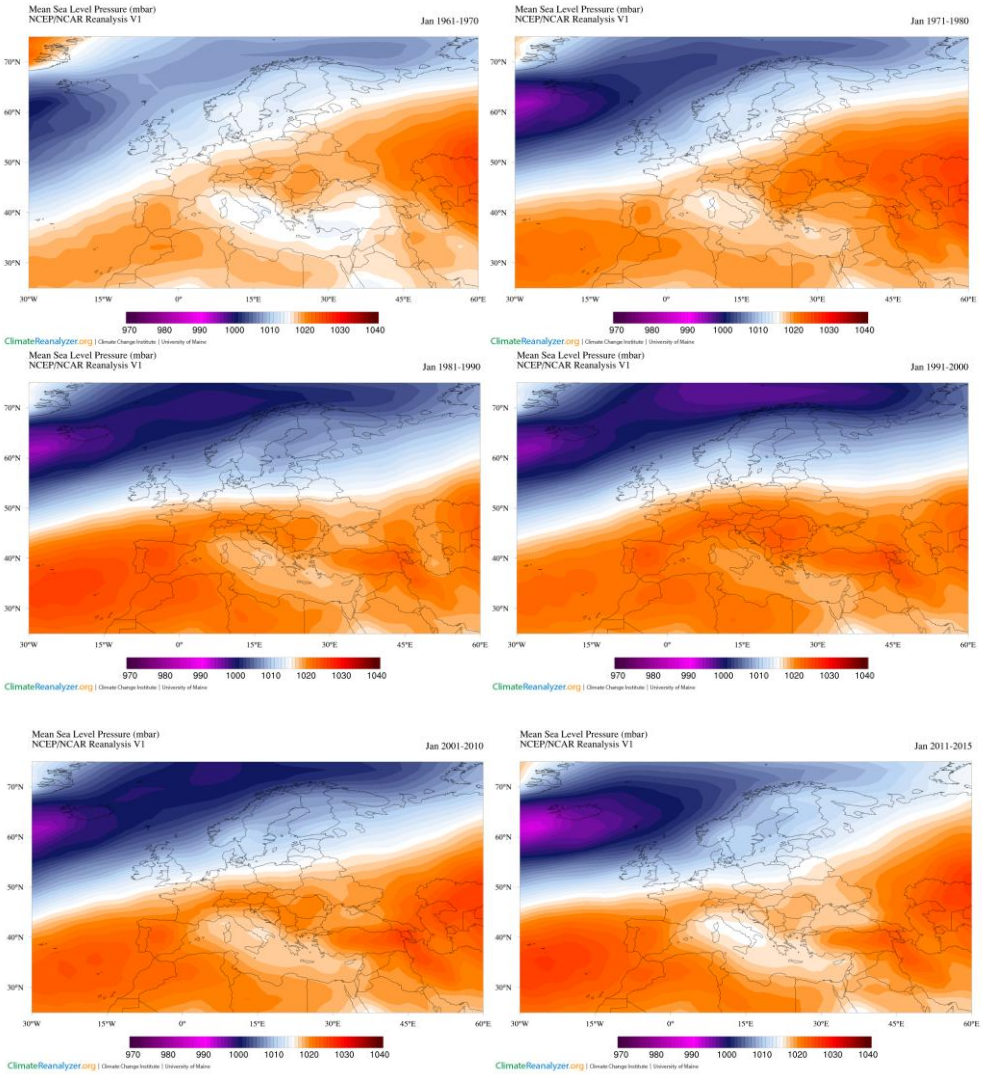


Figure 4. Average pressure at soil on the decades of the period 1961–2015 (reanalyze data NCEP/NCAR)

After the analysis of average pressure field in January, by decades, we can draw some conclusions that justify this non-periodic variability of number of days with blizzard.

- Between 1961-1970 and even 1971-1980 may be noticed a significant influence of anticyclone ridges from Eastern Europe (thermal winter anticyclones) but also the well individualized Mediterranean Depression, centered in the middle of the Mediterranean Sea.
- Since 1981, the appearance frequency of the Azores Anticyclone Ridge was higher (dynamic anticyclone) and the Mediterranean Depression was less represented.
- After 2000, pressure's average configuration for January has not changed significantly, but it may be noticed a slight weakening of the anticyclone field and a cyclone intensification of Mediterranean origin.
- It may also be noted that the North Atlantic depressions were getting better represented in the last decades compared to the period 1961-1970, and together with the Azores Anticyclone Ridge, led across Europe to increasingly common regional movement.The above presented conclusions say to us that although the blizzard is a local phenomenon, the intensity and frequency of production is determined by the changes in the atmospheric circulation in the Euro-Asian continent.These cold air masses had a special dynamic when they were driven by the atmospheric circulation in the rear part of atmospheric cyclones so, is producing sustained wind intensification, accompanied by snow.Mediterranean cyclones are of interest for Bârlad Plateau arriving in the Black Sea and then have a retrograde movement towards this area. So for example, such a case was registered during January, 4 to 7, 1966 (Figure 5) when the wind gust reached at 200 km/h and snow blew strong (Erhan Elena, 2002).In these circumstances, Romanian blizzard occurs in other conditions, often with a greater contribution to the Azores Anticyclone Ridge, but for the analyzed region, snowfalls are not quantitative important, and the wind does not reach great intensity.

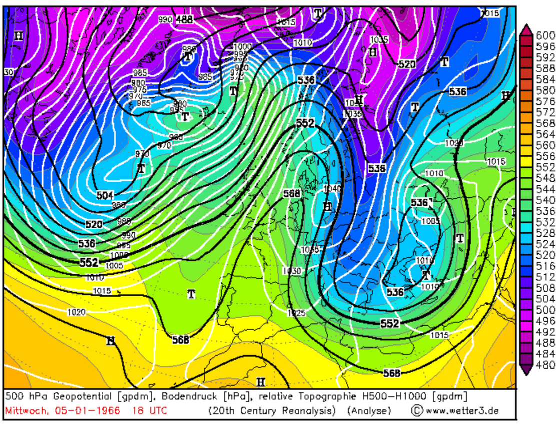
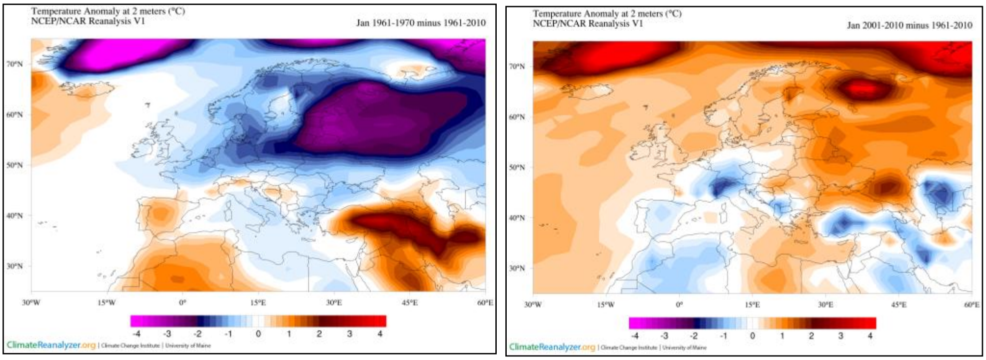


Figure. 5. Pressure at soil and geopotential at 500 hPa in January 5, 1966, illustrating the synoptic situation in which appeared the most powerful blizzard in Moldova

Changes in the distribution of atmospheric pressure at ground level and hence of the types of air movement within Europe, have direct implications on temperatures.Thus, if at the middle of the last century, when winter thermal anticyclones had a greater spatial extent, above the northeastern continent has installed cold air masses (Figure 6 - a), which is supercooled above the snow.

In recent years, the dynamic was more pronounced in the north-eastern Europe, and cold air masses do not have so great stability, and without a snow layer, the heating occurs much faster (Figure 6 - b).



(a) (b)

Figure 6 Average temperatures deviations in January – (a) 1961–1970 decade and (b) 2001–2010 decade from the multiannual average in the period 1961–2010 (reanalyze data NCEP/NCAR)

ERA - Interim reanalysis data confirm the reduction of wind intensity in the central-eastern part of the continent (Figure 7).

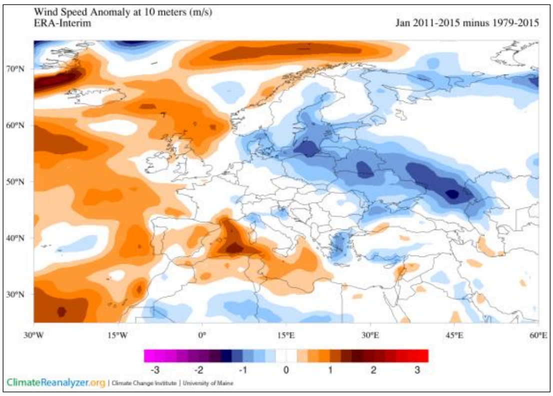


Figure 7 Average speed deviation at 10 m in the period 2011-2015 from the multiannual average in the period 1979–2015 (ERA - Interim reanalyze data)

So for Bârlad Plateau, changes in the distribution of barometric centers, resulting in a reduction in the number of days with blizzards and intensity a little less prominent, but we must not neglect the Black Sea, which in recent years has become increasingly hot and in these conditions, cyclones arrived here tend to intensify and thus prolong its action.

3.6. Risk aspects

The blizzard is a severe weather event, meaning a weather hazard, which has been and will be, in our country and in other parts of the world. Not always, however, blizzards become disasters. This depends on how prepared is the production area to face these phenomena, in other words, **the region's vulnerability**. In the Extra-Carpathian regions, blizzard is a combination of Crivăț with snow or only Crivăț in the presence of a dry snow layer. It is a severe weather event where there exits roughly two types of safeguards: a series of measures being taken after warning being issued and for the production of the phenomenon and other protective measures being taken well in advance (months, years) based on information about the climatological phenomenon. The latter are **temporary snow fences** (which are installed in autumn) **or permanent** (strips of trees or other vegetation). In their absence, a moderate blizzard could cause catastrophic effects, while their presence can master even an intense blizzard.

4. CONCLUSIONS

So there is a downward trend in the number of days with blizzard justified by analyzing the distribution of barometric centers in decades, indicating a weakening of thermal winter anticyclones, and in recent years even a smaller contribution of the Azores Anticyclone Ridge.

Blizzard's intensity for Bârlad Plateau was lower, both due to barometric centers position, but mainly due to weakening of thermal gradients, negative thermal winter anomaly in northeast Europe no longer having a special contribution.

However even ERA - Interim reanalysis data show a weakening of wind intensity in the central part of Europe, checked by the data set analyzed statistically for the Bârlad Plateau.

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