

FREQUENCY OF WARM WINTERS WITHIN OLTENIA IN 1999-2008 DECADE

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ABSTRACT. – In the 20th century, in Romania, warm winters registered a mean frequency of about 1/10-15 years. Once the intensification of climate warming, aspect emphasized by numerous papers published especially after the '90, the frequency of warm winters also increased, as well as that of dry and excessively hot summers. The present paper deals with the analysis of the high frequency of warm winters registered in the decade 1999-2000 – 2008-2009, in Oltenia; 50% of them were included in this category, 10% being very warm and 10% exceptionally warm. In the winter of 2000-2001, it was registered an exceptionally high temperature, which became the absolute maximum temperature value for January. Snow cover was insignificant or absent for long periods. The climatic risk of warm winters occurred on the background of climate warming, which led to the intensification of the circulation of Mediterranean tropical air. Consequently, the vegetative processes start from winter leading to the early development of fruit trees and autumn agricultural crops, which are then greatly damaged by late spring hoarfrost. During the analysed interval, the winters 2000-2001 and 2006-2007 were exceptionally warm, in the last case, the deviations of the monthly and daily means compared to the multiannual means, considered normal, being the greatest in the history of meteorological observations from our country. Warm winters are often followed by dry springs. We used data from the archives of the Oltenia RMC, maps from international meteorological centers and satellite images, on the base of which we classified winters.

Keywords: warm winters, positive temperature deviations, climatic risks, exceptional winter thermal maximums, Mediterranean influences

1. INTRODUCTION

The term of 'warm winter' refers to any winter when seasonal mean temperature and mean monthly temperatures register positive deviations compared to the multiannual means, considered normal values.

The character of warm winter is especially emphasized by positive deviations registered in January, the coldest month of the year (Bogdan, Marinică, 2008).

In the specialized literature, there are mentioned the following warm winters registered in the 20th century in Romania – 1906-1907, 1920-1921, 1935-1936,

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1943-1944, 1947-1948, 1990-1991, which illustrates a mean frequency of about 1/10-15 years.

Warm winters are usually registered in the south of the country, especially in the south-west, where due to the role of orographical barrier, the Carpathians block the circulation of air masses of Mediterranean or tropical origin.

During the 2000-2009 decade, the frequency of warm winters considerably increased on the background of climate warming that results from the analysis of the statistical data rendered below.

2. DATA AND METHODS

We used data from the archives of Oltenia RMC, maps from the international meteorological centers and satellite images. The classification of winters was made on the base of Hellmann's criterion.

Consequently, there have been calculated:

Mean temperature of every winter month (December, January, February) for each station between 1999-2000 and 2008-2009;

Mean temperature of each winter of the analysed decade for each station by summing the mean monthly values (December, January, February) and dividing to 3.

Mean seasonal temperature (for each winter) for the entire Oltenia (considered also the general mean) calculated for plain and hill-plateau regions by summing the mean temperatures for each winter at 14 meteorological stations and dividing the final value to 14; we applied the same method for mountain region, namely we summed the mean temperatures at the 3 meteorological stations and then divided the value to 3.

The normal values (N) for the period 1901-2000 at each station, for each winter month and for the entire winter within Oltenia by summing the values registered at all the station and then dividing to their number;

The deviation of mean temperature for all winter months (December, January, February) compared to their normal for each station;

The deviation of mean temperature registered in each winter of the analysed decade compared to their normal for each station;

The deviation of mean seasonal temperature for the analysed decade compared to its normal for the entire Oltenia;

Establishing weather types for each winter month for the entire winter in Oltenia, according to Hellmann's criterion;

Frequency in percent of the positive deviations compared to the normal, considered warm weather type (WW) by summing the weather types EW, VW, W, WS, respectively of the negative deviations, considered cold weather type (CW) by summing the weather types EC, VC, CL, C, as well as the normal weather (N) for each meteorological station and winter in the entire Oltenia.

In order to render a clearer image of warm winters in Oltenia, where the occurrence probability is the greatest in the country due to its geographical location, the role of orographical barrier of the Carpathians and Mediterranean

influences, the approach was made on major relief steps (plain and hilly-plateau regions together and mountains) for the entire Oltenia.



3. MONTHLY ANALYSIS OF WEATHER TYPES REGISTERED IN THE WINTERS OF 1999-2000 – 2008-2009 DECADE.

In order to better illustrate the thermal character of each winter month of the 10 successive winters from the analysed decade, there were calculated the weather types according to Hellmann's criterion based on deviations of mean monthly temperatures (December, January, February) registered each winter compared to the multiannual mean (1901-2000) for each meteorological station from Oltenia.

Thus, we took into account 17 stations, 14 of them located in low plain and hilly-plateau region and 3 in higher mountain region.

By analysing the mentioned situations, one may notice the high frequency of warm weather (WW) made up by warmish (WS), warm (W), very warm (VW), and exceptionally warm (EW) weather, compared to cold weather (CW) made up by cool (CL), cold (CO), very cold (VC), and exceptionally cold (EC) weather.

The data emphasize *two winters with obvious positive deviations of the monthly thermal regime*. It is about the winter 2000-2001 characterized by warm (W) and warmish (WS) weather in December and warm weather (W) in January and February at all the stations.

The second winter was 2006-2007, when warming processes were more intense than previously, which induced higher mean monthly temperatures and, consequently, higher thermal deviations compared to the normal. This led to their framing in warmer weather types.

Thus, in *December 2006*, weather varied between normal (N) at 3 stations, warmish (WS) at 6 stations and warm (W) at 8 meteorological stations. Then, it follows *January 2007*, when warming processes were very intense and, consequently, the weather was very warm (VW) at all the meteorological stations, except for Parâng station where it was just warm (W). The last winter month of the season, *February 2007* was entirely warm (W), at all the considered meteorological stations. A previous study (Bogdan, Marinică, Rusan, Rusu, 2007) proves that this winter, 2006-2007, was the warmest in the history of meteorological observations in Romania.

The warm winter months (or almost entirely warm, with only one exception especially in the mountains) were: *February 2000* (warm W and warmish, WS and normal N in the mountains); *January 2002* (warmish, WS and warm, W, with two exceptions of normal, N); *February 2002* entirely very warm (VW) within plain and hilly-plateau regions, as well as warm (W) and very warm (VW) in the mountains; *February 2004* with warmish (WS) and warm (W) weather, but normal (N) at one mountain station; *December 2004* when warmish weather predominated (WS), but it was registered warm weather (W) at two stations and normal (N) at one station; *January 2005* with warm weather (W) and one exception of normal (N) in the mountains; *December 2005* with warmish



weather (WS) and four stations with normal weather (N); *February 2008* with warm weather (W) and normal (N) in one case, as well as *December 2008*, mostly warmish (WS), warm (W) at three stations and normal (N) at two mountain stations.

With regard to cold weather (CW), we noticed cold weather (CO) at all the stations associated with cool (CL) and normal (N) weather.

Thus, we mention: *December 2001* characterized by cold weather (CO) within the entire Oltenia at all the stations; *December 2002* with cold weather (CO) in low regions and cool (CL) and normal (N) in high regions; *February 2003* with cold weather (CO) in the entire Oltenia and very cold (VC) at a mountain station; *February 2005* with mostly cold weather (CO), cool (CL), and normal (N) at one station; *January 2006* with mostly cool weather (CL), cold (CO) and normal (N) in the mountains; *December 2007*, characterized by a predominantly cool weather (CL), as well as normal (N); *January 2009* with cool (CL), cold (CO), normal (N) weather and warmish at one station.

4. MONTHLY FREQUENCY OF WEATHER TYPES FOR EACH WINTER MONTH OF THE DECADE 1999-2000 – 2008-2009.

In order to have a clear image and to form an hierarchical system for the winters according to the predominance of warm weather (WW) as well as cold weather (CW: EC, VC, C, CL) compared to normal weather (N), the cumulated monthly frequency (in number of cases and percents) for each time type (EW, VW, W, WS, N, CL CO, VC and EC), was calculated for the three months of winter, as for the whole winter season in the considered decade.

This analysis was performed for both low plain and hilly-plateau regions, as well as for high mountain regions and for the entire Oltenia together.

4.1. Cumulated monthly frequency of weather types according to Hellmann's criterion within plain and hilly-plateau regions

There were considered 14 stations, 7 in the plain region and along valley couloirs (Dr. Tr. Severin, Calafat, Bechet, Băilești, Caracal, Craiova, Slatina) and 7 in the hilly-plateau regions. Taking into account the three winter months, it results that, for each season, there were made observations in 42 months, 14 stations x 3 months. Thus, compared to these 42 months/season, which represents 100%, it was firstly calculated the percent frequency for each type of weather registered in the three winter months at the plain and hilly-plateau stations, and then the cumulated frequency for each winter season, which reflects the warm weather type (WW), with positive deviations (EW, VW, W, WS) and of the cold weather type (CW), with negative deviations (EC, VC, C, Cl), compared to the normal weather (N).

Thus, there clearly results that two winters, namely 2001-2002 and 2006-2007, were characterized by warm weather. It is worth mentioning there was not registered any negative deviation.

Consequently, in the ten analysed winters, one may notice:



One winter (2003-2004) when normal weather (N) predominated registering a cumulated monthly frequency of 57.1%; it decreasingly follows warm weather (WW) with a frequency of 33.4% and cold weather (CW) with 9.5%;

6 winters (1999-2000; 2000-2001; 2001-2002; 2004-2005; 2006-2007; 2008-2009) when warm weather (WW) predominated; its cumulated monthly frequency varied between >35% and 100% per season. Together with the winter 2003-2004, when warm weather (33.4%) was three times more frequent than cold weather (9.5%), there results 7 warm winters;

3 winters (2002-2003; 2005-2006; 2007-2008) were cold, registering a cumulated frequency of cold weather that varied between >38% and >66% per season.

On the whole, during this decade, the frequency of warm months (WW) was of 53.3%, namely almost double compared to the frequency of the months with cold weather (CW) that reached 28.1%.

It results, from the aforementioned information, a frequency of warm winters (when positive deviations predominated compared to the negative ones) of 2/1, namely two times more warm winters than cold winters in low plain and hilly-plateau regions.

Among warm winters, we remark two:

The winter 2000-2001 during which all the months (December, January, February) at all the stations located in the plain and hilly-plateau regions were warm (CO) or warmish (WS), which meant a cumulated frequency of warm weather of 100%. This represents the winter with the highest cumulated frequency of warm weather (WW) during the analysed decade, as there was not registered any month with cool (CL), cold (CO) or normal (N) weather.

In spite of all these, it was not the warmest winter. If we take into account the temperature deviations in the coldest month, January, compared to the multiannual mean, they varied between 2.9°C at Dr. Tr. Severin and Calafat stations (equal to the one registered at Voineasa) and +3.6°C at Caracal and Rm. Vâlcea. In Craiova, located in the central part of Oltenia, it reached 3.5°C, which means there was warm weather (W).

It is worth mentioning that in January 2001, there was registered the absolute maximum temperature of the month in Romania, 22.2°C/January 7 (Marinică, 2002, 2006; Bogdan, Marinică 2007).

The winter 2006-2007 was the second warm winter in terms of monthly cumulated frequency of warm weather (WW), 95.2% (after the above-mentioned winter when the frequency reached 100%) and the first in terms of deviation value. Thus, during the 2007 winter, all the deviations were positive and, according to their values, there predominated very warm weather (VW). They varied between 6°C at Tg. Logrești station (with only 0.1°C higher than the one at Voineasa) and +9.2°C at Calafat, the greatest in the history of meteorological observations in Romania. If we also take into account the warm (W) and warmish (WS) weather registered in the two winter months, we may say this was the warmest winter of the decade.



The previous research referring to this winter (Bogdan, Marinică & al., 2007) emphasized that this was the warmest winter not only in Oltenia, but in the entire Romania; we mention positive deviations, similar to those registered at Calafat, even in the depression area of Giurgeu – Ciuc – Brașov, where there usually is the cold pole of the country.

4.2. Cumulated monthly frequency of weather types according to Hellmann's criterion within the mountain regions

There were considered 3 stations (Voineasa, Ob. Lotrului and Parâng, which is located in Hunedoara County, but it is representative for the entire mountain region of Oltenia). They totalized 9 winter months for each winter season during the analysed decade. We mention that we do not have any observations for the winter 2003-2004 at Ob. Lotrului.

Mean monthly temperature deviations compared to the normal in the three winter months of the analysed decade for each mountain station emphasized that there predominate the positive ones, namely warm weather (WW).

We remark the same warm winters, 2000-2001, with a cumulated monthly frequency of 77.8% and 2006-2007 with 88.9%. None of these winters registered months with cold weather. However, compared to the plain and hilly-plateau regions, where, in the first case, it was registered the highest cumulated monthly frequency of warm weather (100%) while, in the second case, the greatest thermal deviations ($>9^{\circ}\text{C}$), in the mountain regions, the winter 2006-2007 registered both the highest frequency and the greatest thermal deviations of the analysed decade, which indicate the occurrence of warm (W) and very warm (VW) weather.

The second winter in terms of high cumulated monthly frequency of warm weather is that of 2001-2002 (66.7%).

This is a winter of thermal contrasts, as there was registered cold (C; 22.2%), very cold (VC; 11.1%), as well as very warm (VW; 22.2%) weather in February, while in January it predominated warm weather (33.4%).

The coldest winter was 2002-2003, when it was registered cool (C; 22.2%), cold (C; 22.2%) and very cold (VC; 11.2%) weather summing 66.6%.

We noticed in the mountain region in the analysed decade:

5 warm winters (2000-2001; 2001-2002; 2004-2005; 2006-2007; 2007-2008) when there predominated positive deviations and the cumulated monthly frequency of warm weather (WW) varied between 44.5% and 88.9%;

4 winters (1999-2000; 2003-2004; 2005-2006 and 2008-2009) with predominantly normal weather (N), when the cumulated monthly frequency varied between 44.5% and 88.9%;

A single winter (2002-2003) when negative deviations predominated, registering a cumulated monthly frequency of 66.7%; this is the second winter when it occurred very cold weather (VC; 11.2%), as we rendered before.

During the entire analysed decade, the frequency of warm weather (WW) reached 43.7%, namely a little higher than the double of the frequency of cold weather months (CW) that was 21.8%.



Consequently, we remark that, in the mountain region, the frequency of warm winters is 2/1, of the normal winters of 2/1-2, and of cold winters of 1/10.

Compared to the plain and hilly-plateau regions, in the mountains, the frequency of warm months decreases (from 6 to 5 and that of cold months from 3 to 1), but we registered an increase of the frequency of normal months (from 1 to 4).

The lack of exceptionally cold months in the mountains, the reduced frequency of cold and cool months, the higher frequency of normal months and especially of warmish, warm and even very warm months emphasize a warming of the mountain climate during winter in the last decade, which confirms the conclusions drawn by other authors with regard to global warming.

4.3. Cumulated monthly frequency of weather types according to Hellmann's criterion for the entire Oltenia

In this case, there were analysed the deviations of mean monthly temperatures of each winter from the respective decade compared to the normal values in Oltenia. Monthly means and normal values for the entire Oltenia resulted from the sum of the winter months means (10 values) (1999-2000 – 2008-2009), respectively the multiannual period (1901-2000) at all the 14 stations, which we also called general monthly mean on 10 years compared to the general mean on 100 years.

Analysing the mentioned situations, we may notice the predominance of positive deviations compared to the negative or normal ones:

5 winters (1999-2000; 2000-2001; 2001-2002; 2004-2005; 2006-2007) registered predominantly warm weather (WW), the monthly frequency varying between 66.7% and 100%;

One winter (2003-2004) was characterized by the predominance of normal weather (N), with a cumulated monthly frequency of 66.7%;

One winter (2002-2003) was characterized by the predominance of cold weather (CW), with a frequency of 66.7%;

3 winters (2005-2006; 2007-2008 și 2008-2009) registered equal cumulated monthly frequencies of warm (WW), normal (N), and cold (CW) weather, 33.3-33.4%.

For warm weather (WW), we noticed the *warm winters 2000-2001 and 2006-2007*, as well as the other analysed cases, when its frequency was the same in both cases, 100%, and there was registered no month with normal (N), cool (CL) or cold (CO) weather. However, the value of the deviations was greater in the winter 2006-2007, when we registered very warm weather (VW), as one may notice for the two major landforms separately.

Overall, in Oltenia, of the 10 winters that represent 30 months, there were: 2 months (6.7%) with very warm weather (VW); 6 months (20%) with warm weather (W); 9 months (30%) with warmish weather (WS), which sum more than 50% (56.7%) of the total number of winter months from the analysed decade.

It decreasingly follows the cool (CL) with 4 months (13.3%) and cold (CO) weather, 4 months (13.3%), which represents 26.6%, and 5 months with normal weather (N), respectively 16.7%.



If we take into account the warm (WW) (56.7%) and normal weather (16.7%), summing about 75%, we notice that the cold weather reduced to about 25%, which emphasize the warming of winter months in Oltenia.

If we refer to mean seasonal temperature deviations, the weather types in the analysed decade according to Hellmann's criterion for the entire Oltenia are rendered.

If we take into account the seasonal temperature means for the entire Oltenia, a single winter was cold (CO), the winter 2002-2003, two were normal (N) (2005-2006 and 2008-2009) and seven were warm; two of these warm winters were *very warm* (VW) (2000-2001 and 2006-2007), one *exceptionally warm* (EW), the last one registering the greatest deviation from the general normal mean, 5.00°C.

According to the general decade mean, the entire decade was warmish (WS) in Oltenia, as well as January and February.

If we take into account the means of January and the deviations from the normal, we shall notice that the deviations varied between 5.9°C at Voineasa and 9.2°C at Calafat in the winter 2006-2007. The winter 2001-2002 registered a *very warm* (VW) February within the entire Oltenia and the deviations of the means compared to the normal values oscillated between 5.3°C at Apa Neagră and Tg. Logrești and 7.6°C at Drăgășani. For the first 9 winters (1999-2000...2007-2008), the graphical representation of the mean temperature values for the entire region emphasize a linear upward tendency. The hierarchy of the winters according to the increasing mean temperature values is 2002-2003, 2005-2006, 2008-2009, 2007-2008, 2003-2004, 1999-2000, 2004-2005, 2001-2002, 2000-2001, 2006-2007.

5. CONCLUSIONS

We consider that the frequency of warm winters increased in the last decade (1999-2000 – 2008-2009) in Oltenia due to global warming..

Thus, in Oltenia, there were registered the following *warm winters*: 2000-2001; 2001-2002; 2004-2005; 2006-2007⁴. We may consider the winter 1999-2000 as a warm winter, except for the mountain region where it was normal.

2002-2003 was a *cold winter* in Oltenia, while 2003-2004 was normal.

The winters 2005-2006, 2007-2008 and 2008-2009 were characterized by equal frequencies of the three weather types.

Thus, we notice the predominance of warm winters.

The phenomenon is very well emphasized as there occur sub-Mediterranean influences characterized by a higher frequency of warm Mediterranean air advections.

⁴ According to Hellmann's criterion applied to the general mean for the entire region with altitudes below 600 m, the winter 2006-2007 was exceptionally warm (EW), except for the mountain region, registering the highest deviation compared to the general normal mean, 5.00°C. This is the only exceptionally warm winter in the history of meteorological observations from our country.



REFERENCES

1. Octavia, Bogdan, Ion, Marinică (2007), *Hazarde meteo-climatice din zona temperată geneză și vulnerabilitate cu aplicații la România*, Edit. Univ. „Lucian Blaga”, Sibiu, ISBN 978-973-739-465-1, 422 p.
2. Octavia Bogdan, Ion, Marinică (2008), *Iarnă mediteraneeană în Oltenia, 2006-2007*, Rev. Geog. **XIV-XV**/2007-2008, serie nouă, ISSN 1224 – 256 X, p. 26-36.
3. Octavia, Bogdan, Ion, Marinică (2008), Caracteristici ale valurilor de cădură din Carpații Meridionali, în vol. Carpații Meridionali clima, hazardele meteo-climatice și impactul lor asupra turismului, editor Octavia Bogdan, p. 89-99, Edit. Univ. „Lucian Blaga”, Sibiu, ISBN: 978-973-739-623-5.
4. Octavia, Bogdan, Ion, Marinică, Loredana-Elena Mic (2008), *Considerații asupra „Fenomenului de iarnă caldă” din România*, Com. Geog. **XII**, Univ. din București, Facultatea de Geografie, p. 139-144;
5. Octavia, Bogdan, Ion Marinică (2009), *Caracteristici climatice ale iernii 2007-2008 în Oltenia*, Rev. Geog. **XVI**, 2009, serie nouă, ISSN 1224 – 256 X, pp 73-81.
6. Bogdan, Marinică, I., Rusan, N., Rusu, Simona (2007), *Riscul iernilor calde în România (cu aplicații la iarna 2006-2007)*, Riscuri și Catastrofe, editor V. Sorocvoschi, **VI**, 4/2007, p. 97-110.
7. Marinică, Ion (2002), *Iarna caldă în Oltenia*, Forum Geografic, **I**, 1 Edit. Univ. Craiova, ISSN – 1883 – 1523, p. 165 – 171;
8. Marinică, Ion (2005), *Viscolul din 23 – 24 ianuarie 2004*, Rev. Geog. **XI**/2004, serie nouă, București, ISSN 1224 – 256 X, p. 74-80;
9. Marinică, Ion (2006), *Fenomene climatice de risc în Oltenia*, Edit. Autograf MJM, ISBN 973-87422-0-X , CRAIOVA, 386 p;