COMPARATIVE STUDY - SYNOPTIC AND CLIMATOLOGIC CHARACTERIZATION FOR WINTER 2011/2012 AND WINTER 2012/2013

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Abstract

The starting point of this paper was the very different aspect of the weather in winter 2011/2012 compared to winter 2012/2013. Winter season 2011/2012 started with warm weather and precipitation mostly as rain. In late January 2012 and the first half of February 2012 the weather was extremely cold , the snow was abundant and a consistent snow layer deposited. In contrast, winter 2012/2013 started in force, with heavy snow in early December 2012, but ended with warm weather, rains, and without snow layer. Therefore we considered useful both a climatologic analysis of interval December 2011-February 2012 and December 2012-February 2013, and a synoptic analysis of these intervals, to highlight synoptic situations that cause a particular aspect of weather. For the climatologic characterization there was analyzed spatial and temporal evolution of different climatic parameters at three weather stations of Banat Timişoara, Sânnicolau Mare and Banloc. Meteorological parameters considered in this study are air temperature, rainfall and snow. In data processing it was given a great importance for the extreme values and for monthly averages. We did an analysis on the number of frosty nights, the number of days of winter and freezing days, and the number of days with snow layer. In order to draw up the synoptic characterization we used maps with pressure distribution at ground level and with height at 500 hPa level. We were also analyzed thermal and heights anomalies. Thus were highlighted aero-synoptic structures responsible for some cases of severe weather. We noted the persistence of the East-European Anticyclone in winter 2012 compared to winter 2013, when it almost has not made felt its presence. In the synoptic study there were made references to the weather aspect on the European continent, in order to get a more complete picture of the phenomena studied.

Key words: *thermal regime, rainfall regime, thermal anomaly, snow layer, frost, freezing*

INTRODUCTION

Contrasting aspects of weather events in the winter season 2011 - 2012, respectively 2012 - 2013, and the extreme values of meteorological parameters recorded in the two cases, led to the idea of a more detailed study on the more special events in the two cases, in terms of weather. The analysis was done both in terms of climatologic and synoptic point of view, on the intervals in December 2011 - February 2012 respectively in December 2012 - February 2013. The aim was to highlight the synoptic situations that cause a particular aspect of the weather and, especially, those that generated the event of severe weather, with extreme values of meteorological parameters and large deviations from the average annual values.

MATERIAL AND METHODS

For the climatologic analysis meteorological parameters were considered for three weather stations in Banat, namely: Timisoara, Sânnicolau Mare and Banloc. Data were processed regarding air temperature, rainfall and snow. Also, an analysis was made concerning the number of frosty nights, the number of winter days and number of days with frost, and the number of days in which there was snow cover (layer). The analyzed data were compared to the multiannual average for the 1961 – 2000 periods.

For the synoptic characterization of the given time ranges, maps with the distribution of pressure on ground level and the of the 500 mb level geopotential were used. Thermal and

geopotential anomalies were also analyzed. In the synoptic study, references were made to the weather aspect of the European continent, to get a more complete picture of the studied phenomena.

RESULTS AND DISCUSSIONS

- CLIMATOLOGIC ANALYSIS

An overview of the spatial and temporal evolution of meteorological parameters significant for the two winter seasons taken into consideration can be obtained from analyzing data systematized and processed in the following tables and graphs:

Table 1

No. winter days (maximum temperature ≤ 0°C)

Station	December 2011	December 2012	January 2012	January 2013	February 2012	February 2013
Timişoara	4	9	4	4	17	1
Sânnicolau Mare	3	11	4	6	19	3
Banloc	3	9	5	5	18	2

As can be seen in Table 1, the number of winter days (maximum temperature ≤ 0°C) was at least twice in December 2012 over December 2011. If the months of January corresponding to the two winters are comparable in terms of the studied parameter, between February 2012 and February 2013 there is a major discrepancy, winter days occupying two thirds of February 2012, while in February 2013 their presence was scarcely felt.

Regarding the minimum temperature during the nights, during the two winter seasons, similar conclusions can be drawn from the analysis of Tables 2 and 3.

Table 2

No. days with frost (minimum temperature ≤ 0°C)

Station	December 2011	December 2012	January 2012	January 2013	February 2012	February 2013
Timişoara	18	25	25	22	28	10
Sânnicolau Mare	17	23	24	20	27	14
Banloc	16	24	22	19	27	8

Table 3

No. cold nights (minimum temperature ≤-10°C)

Station	December 2011	December 2012	January 2012	January 2013	February 2012	February 2013
Timişoara	-	4	4	1	13	-
Sânnicolau Mare	-	3	2	1	15	-
Banloc	-	4	4	2	12	1

It can be seen from the data in Table 2 that the nights the temperature dropped below 0°C, were 25-30% more numerous in December 2012 than in December 2011, and of these, according to data in Table 3, 13-16% have been frosty in 2012, while in December 2011 the air temperature has not dropped below 10°C at night. For the months of January of both years the number of days with frost was comparable, as was the number of winter days, but the number of cold nights was at least twice in January 2012 compared to January 2013. For the months of February in the two winter seasons a very big difference is observed again: in February 2012 the air temperature dropped below 0°C in 95% of the nights, half of which are characterized by minimum temperatures of ≤ -10°C, in February 2013 air temperature dropped below 0°C in less than half the nights and frosty nights were almost absent.

Regarding persistence of snow and its maximum height, the data in Tables 4 and 5 highlight again large differences between the months of December of the two winter seasons, and also between the months of February.

Table 4

No. days with snow cover

Station	December 2011	December 2012	January 2012	January 2013	February 2012	February 2013
Timişoara	1	18	8	7	27	2
Sânnicolau Mare	-	11	4	9	26	3
Banloc	2	20	9	11	27	3

Table 5

Maximum layer of snow (in cm)

Station	December 2011	December 2012	January 2012	January 2013	February 2012	February 2013
Timişoara	1	33	5	10	40	4
Sânnicolau Mare	-	16	1	7	29	4
Banloc	1	47	4	16	43	8

While in December 2011 almost lacked snow layer, about half of the month December 2012 the ground was covered with snow, the number of days with snow being two or three times higher than normal. The number of days with snow cover in January 2012 was close to the corresponding month of January 2013, both being smaller than normal for this month. Instead, in February 2012 the snow was present about 90% of the time, recording an absolute record for snow depth (40 cm in Timişoara). In February 2013 the snow was up to 10% of the time, and its thickness was generally less than 5 cm.

We can also make an image of the weather development in thermal aspect, but also in terms of rainfall during the three winter months, by studying the comparative graphs for the monthly average temperature and seasonal average temperature, respectively for monthly and seasonal quantities of precipitations. Graphs were made for the weather station in Timişoara, for the months /winter seasons 2011 - 2012, respectively 2012-2013.

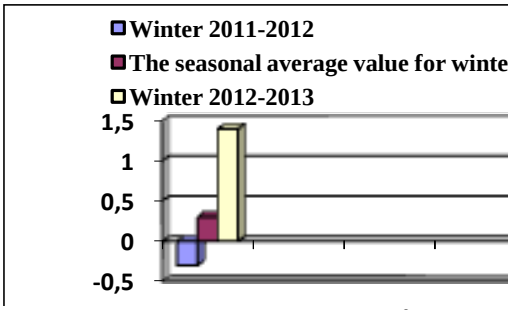

Figure 1. The seasonal average temperature (in ^{o}C) – Timişoara

The seasonal average temperature value in Timisoara (Figure 1) for winter 2011-2012 was two times lower than its multiannual average, while for winter 2012-2013 it was over four times higher than average. This leads us to the idea that winter 2012 - 2013 was much warmer than the previous one.

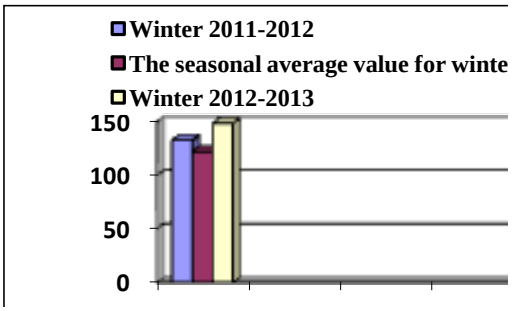

Figure 2. The seasonal quantities of precipitations (in mm) - Timişoara

Figure 2 shows that for both winter seasons studied, the seasonal quantities of precipitation were higher than the multiannual average, the corresponding value in the winter of 2012-2013 being about 10% higher than in the previous winter.

Further analyzing the graphs in Figures 3 and 4 we can compare both the monthly average temperatures and monthly precipitation amounts in Timisoara, for the given time ranges.

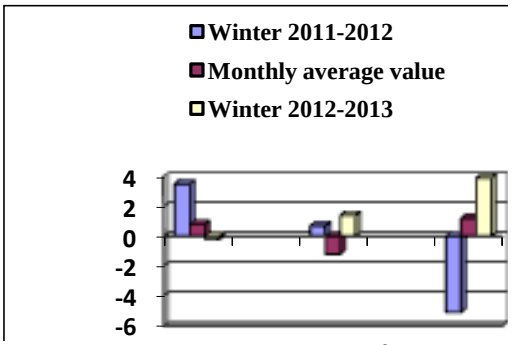

Figure 3. Monthly average temperature (in ^{o}C) – Timişoara

According to the graph in Figure 3, the winter months of December and January from 2011 to 2012 stood at above usual monthly average temperature, while February was colder than normal (5 times). In the winter 2012 - 2013, December was a little cooler than normal, but January and especially February were considerably warmer giving the entire season its appropriate appearance.

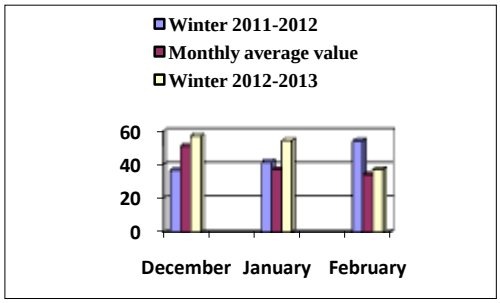

Figure 4. Monthly precipitation amount (in mm) – Timişoara

Regarding the monthly amount of precipitation (Figure 4), there is an excess of average multiannual values for 5 of the 6 months counted, the month with the least precipitation and also below the annual average being December 2011 (36.9 mm). December 2012 was, however, the richest in precipitation (57 mm).

- **SINOPTIC ANALYSIS**

Winter 2011/2012 has left long awaited. After a very dry November, December 2011 started with a warm weather and almost no precipitation. Expanding of Iceland Depression led to breaking the atmospheric blocking that persisted during November. Romania was in the warm sector of this vast depression. In this sector warm air masses of tropical origin are drawn to the center of the cyclone. In this context, on 5 December 2011 the maximum temperatures had reached in Banat even 15 ^{o}C. During the night rain started and then this warm air was replaced by a polar air mass, slightly colder. In the next few days the temperatures have never exceeded 10^{o}C at noon, and were slightly negative during the nights.

From December 12 another series of Atlantic cyclones had moved eastward, carrying warm air masses within European continent. Thus, the 0 º C isotherm, was pushed to the extreme northern and north-eastern part of the continent. The weather has warmed up again in western Romania, night temperatures were positive and it was raining on large area.

The first snowfall of 2011-2012 winter season occurred only on 20 December, when, finally, there was a cooling process. But snow was quantitatively weak, and only in the northern and eastern part of Romania and on the hills and mountains snow cover has been submitted. On Christmas, few snowflakes fell, but daytime temperatures were positive and snow did not last. The same thing happened in the last days of December 2011.

January 2012 began with warm weather, not only to us where, except the few regions covered by fog, temperatures climbed up to 10-15 º C, but throughout all Europe.

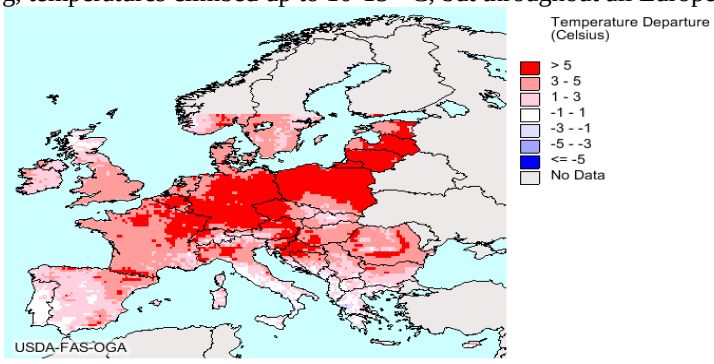

Figure 5. Average temperature departure from normal 01.01-10.01 2012

From January 7, once with the transformation of the western circulation in Arctic circulation, the weather has cooled slightly and there were the first snow of the year 2012. The snow layer did not exceed 4 ... 5 cm in the Banatian Plain. After translation of this cooler air from west to east across the continent, western circulation has reentered the rights, which led to a new warming of the weather.

A stronger weather cooling occurred after January 15, together with an enhanced advection of cold, polar-maritime air. Thus, 17 January 2012 was the first day of real winter in this year, a day when maximum temperatures remained negative, it snowed on extensive areas

and snow layer reached 4-5 cm in the plains. The expansion of Azores High and Iceland Depression pushed the cold air mass to the extreme eastern Europe and the weather warmed again in our region. Rainfall was predominantly as rain and maximum temperatures reached even 11 º C on January 23.

The development of a thalweg from Iceland Depression facilitated the formation of a cyclone over the Apennine Peninsula. As it moves eastward, this cyclone brought quantitatively significant precipitation, rain at first, then as snow. Coupling of this Mediterranean cyclone with Eastern European Anticyclone, very well developed, is a typical situation for blizzard to the southern and eastern of the country.

In Banat the weather has cooled slightly from day to day, but the precipitation was mostly as rain. In southern Banat it snowed and the snow layer was consistent. Generally moderate wind blew from the north. In the last two days of January, East-European High has gained ground and a very cold, polar continental air mass; it was felt in western Romania. Minimum temperatures fell below -10 ° C, and in the depressions even below -20 º C. Unfortunately, these low temperatures in Banatian Plain surprised the autumn crops uncovered by snow. This cold wave has not affected only Romania, but all the continent, its maximum intensity was located in Eastern Europe, where minimum temperatures often dropped below -20 º C.

In early February the weather was very cold, frosty during nights. Baric configuration of these days, with Siberian anticyclone highly developed, expanded and united with Azores High, is the typical model of large cold waves that can affect the whole of Europe. Cold air transported, but also produced by the anticyclone, penetrated to northern Africa, causing snow storms even in northwest Africa, where snowfall is rare.

Penetration of cold air over the western and central Mediterranean spurred cyclogenesis in this region. Placed in the anterior part of the Mediterranean cyclone, the western part of our country received abundant snow in the warm front associated. All the Banatian Plain has had snow layer of about 30 cm, with a maximum of 37 cm in Timisoara on the morning of February 5. Meanwhile in southern and eastern of Romania warm air mass driven by the cyclone failed to dislodge the cold air from the ground and slid over it. In this context, the phenomenon of freezing rain appeared.

In the following days the frost had been installed in Banat. For four consecutive nights minimum temperatures fell below -20 º C, recorded -28.3 ° C to Jimbolia on February 9. Daytime temperatures were also negative, even stayed around -10 ° C on some days.

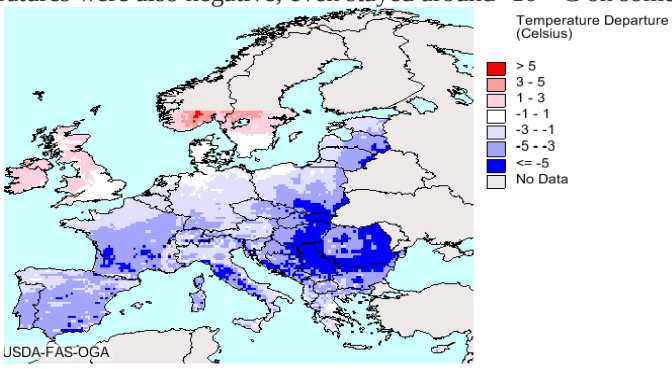

Figure 6. Average temperature departure from normal 10.02-20.02 2012

A certain softening of frost occurred on 12 February, when another cyclone formed in the Mediterranean has brought a new wave of snow. Snow layer, slightly compacted in recent days, increased again and reached 43 cm in Banloc and 40 cm in Timisoara. The snow layer was a record made for the last 20 years.

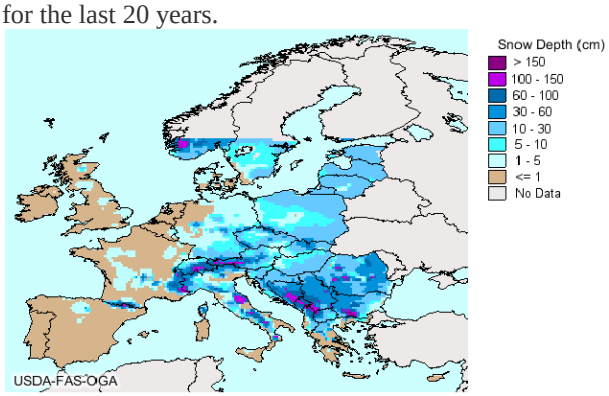

Figure 7. Snow depth (cm) 10.02-20.02 2012

From February 18 atmospheric circulation became western and weather was entered in a warming process. Maximum temperatures were positive, and minimum temperatures have never fallen below -10 ° C, even, in some overcast nights, they were positive. The snow has melted gradually, so that at the end of February the ground was covered only by a thin and discontinuous layer of snow and there were no problems with flooding.

Unlike last year, when the first part of December was characterized by thermal values over climatologic averages, in 2012 meteorological winter came about at the same time with the calendar winter. In the first days of December 2012 a wave of cold air had spread over most of Europe, so that the only areas where we could speak about thermal values close to normal for this period were those of south-west Europe and the extreme eastern part of the continent. This arctic air, that has entered from the north, in conjunction with Mediterranean cyclonic activity, materialized in the southern half of Europe by low temperatures and important precipitation predominantly as snow.

In western Romania weather has cooled gradually, first snowfalls appeared, for the beginning in hill and mountain areas, then in the plains. Since December 8 the Mediterranean cyclone that caused heavy snowfalls and blizzard in Croatia, Slovenia, Serbia and southern Hungary, affect Romania too. In the morning of 9 December on several roads in the country the traffic was hampered or even stopped due to heavy snowfalls and blizzard. In western Romania the snow layer measure 45 cm in Jimbolia, 40 cm in Banloc, and 33 cm in Timisoara.

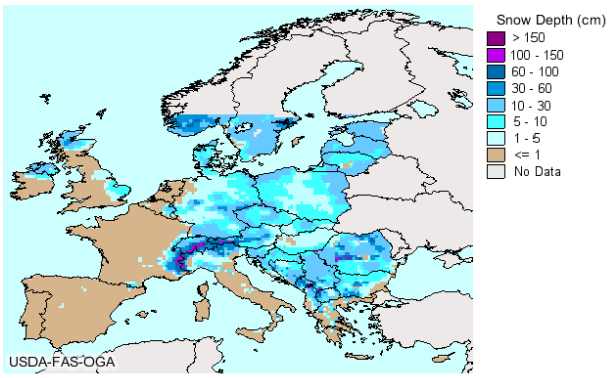

Figure 8. Snow depth (cm) 10.12-20.12 2012

After this episode with abundant snowfall, frost settled in the west, so in December 10 2012 minimum temperature dropped to-22^{o}C to Jimbolia and -21.4 ^{o}C to Banloc. In the next few days it snowed again, this time more abundant in Caras-Severin County. Heavy snowfalls were in other parts of the country, and in Moldova was blizzard. Temperatures below -10 ° C during nights and slightly negative maximum temperatures occurred until December 16, when the weather started to warm up slightly.

Since December 16, the synoptic situation changed radically. Siberian anticyclone weakened and retreated to the eastern extremity of the continent, facilitating the extension of North Atlantic cyclones over much of Western Europe, and even to its center. Over the southern half of Europe has extended an anticyclone which facilitated the advection of warm and humid air. In western part of Romania the weather has warmed up gradually, reaching maximum temperatures about 7 ... 8°C. Under these circumstances, and following precipitation as rain, snow melted almost throughout the region.

The advancement of warm air continued till late December. Most of Europe has had a warmer weather than usual in late December. In Banat the weather was warm, the maximum temperature had reached even 19 ° C on Christmas day, minimum temperatures had been around 0 ° C and there were very little rainfalls.

By climatologic aspect, the first week of 2013 started with a warmer than usual weather in much of Europe. Also in western part of Romania January 2013 started with a slightly warmer weather than usual, even though the first morning, amid a mostly clear sky, minimum temperatures were around -5 ... -7 ^{o}C.

Starting from January 7 the weather has entered in a cooling process, withal the movement of a continental polar air mass to the eastern and southeastern Europe. In Banat it snowed on wide areas, but fresh snow layer did not exceed 5 ... 6 cm in the lowlands. Then there were several days with maximum temperatures that have not exceeded 0 ° C, and a few cold nights with temperatures below -10 ° C.

After January 11th the weather entered again in a warming process. Precipitation has been in the form of rain and the snow has melted.

From 19th January the weather was cooled again. Advancement of polar air to the center continent in conjunction with a Mediterranean cyclonic activity resulted in precipitation mostly in the form of snow in most of central, southern and western continent. In western Romania snowed and the snow layer deposited in the Banatian Plain reached up to 15 cm. Atmospheric circulation has changed rapidly, another series of cyclones formed in the Mediterranean, favoring warm air advection to our area of interest. There were several days in

which maximum temperatures frequently exceeded the 10 °C and nights when the temperatures dropped below 0 °C.

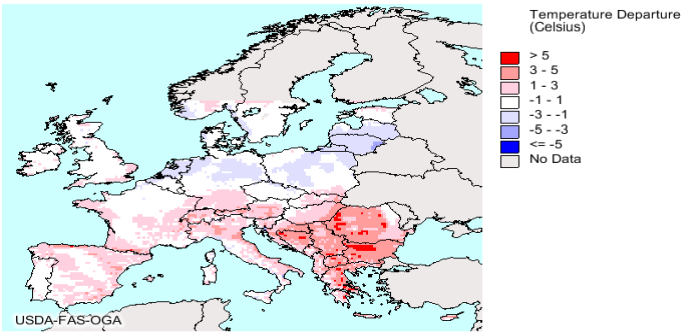

Figure 9. Average temperature departure from normal 21.01-31.01 2013

January ended with warm weather for this time of year. Night temperatures did not drop below -5 °C, the maximum temperatures reached even 11 ... 12 °C on the last day of the month, and rainfall were predominantly as rain.

Thermal values well above the climatologic averages had remained in Eastern Europe, also in early February 2013.

A slight weather cooling occurred in Banat since February 9. It snowed and the snow layer was up to 7 ... 8 cm. But from February 12 thermal values increased again and the snow has melted. Minimum temperatures were generally positive, so the absence of snow layer did not affect winter crops.

CONCLUSIONS

Based on the data in Tables 1-5 it can be concluded that in winter 2011-2012 December and January were relatively mild, but February was very cold, with extreme manifestations of the phenomena characteristic of winter. In contrast, in the winter that followed, December was the month that made its mark on the characteristics of this season.

Analysis of ground and upper air maps illustrates the typical situations. Thus, in December 2011 the zonal circulation prevailing, which resulted in warm weather with a slight deficit of precipitation? In December 2012 the Mediterranean Cyclone was more active and Eastern European anticyclone has made its presence felt. Under these conditions the weather was cold, with significant rainfall and episodes of blizzard.

In the month of January, both in 2012 and in 2013, the weather was warmer than normal, with excess of precipitation. The positive deviation was higher in January 2013. In both cases there was a combined cyclonic activity both Mediterranean and Atlantic.

In February 2012 the atmospheric blocking had imposed on the movement of atmospheric air a northern component. East European High persisted many days and has swept much of Europe. The weather was very cold, with long periods of frost, it snowed abundant and there have been several episodes of blizzard. Instead, in February 2013 atmospheric circulation facilitated the advection of warm air masses, of North African origin.

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