

SEVERE WEATHER COOLING CAUSED BY THE SCANDINAVIAN ANTICYCLONE

RĂCIRI ACCENTUATE ALE VREMII DETERMINATE DE ANTICICLONUL SCANDINAV

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Abstract: The sudden and severe weather cooling are meteorological phenomena that have a great impact on the population and negative consequences in various economic fields. One of the pressure centres that facilitate penetration of arctic air masses to the area of Romania is the Scandinavian Anticyclone. These masses of air cause sudden and spectacular changes in weather aspect, consisting of severe drop of air temperature, intense frost in winter, snowstorm, rime and frost on the ground in spring and autumn.

Rezumat: Răcirile bruște și accentuate ale vremii sunt evenimente meteorologice deosebite, care au un mare impact asupra populației și consecințe negative în diferite sectoare economice. Unul dintre centri barici care facilitează pătrunderea maselor de aer arctic până în zona României este Anticicloul Scandinav. Aceste mase de aer determină schimbări bruște și spectaculoase în aspectul vremii, care constau în scăderi accentuate ale temperaturii aerului, geruri intense iarna, viscol, brume și înghețuri la sol primăvara sau toamna.

Key words: Scandinavian Anticyclone, severe cooling, minimum temperatures, rime, frost on the ground
Cuvinte cheie: Anticicloul Scandinav, răciri intense, temperaturi minime, brumă, îngheț la sol

INTRODUCTION

In the operative weather service, when forecasting dangerous weather phenomena, warning messages are sent to the authorities and to the population.

The air temperature is a weather parameter with great impact on human society, both from the point of view of human body behaviour and from that of economic life. That is why, when forecasting severe cooling or heating of weather, it is necessary to warn the population in advance.

The sudden and severe weather cooling has a negative impact in several fields, and can affect the health condition of persons with chronic diseases.

One of the synoptic situations causing severe dropping of air temperature on the Romanian territory is in connection with the Scandinavian Anticyclone.

The Scandinavian Anticyclone is a secondary pressure centre acting in Europe. Its frequency is reduced, 30 days a year on the average, which means about 8-9%. However, the Scandinavian High is the main generator of continental arctic air masses. The influence of these air masses can be felt on a widespread area, which often includes Romania, Northern Bulgaria and Central Europe.

These air masses cause sudden and important changes in weather evolution, consisting of severe dropping of air temperature, intense frost in the wintertime, wind enhancement, but above all, the late or early rime or frost in autumn and spring.

That is why we consider it necessary to study the Scandinavian Anticyclone and its influence on the weather aspect in the western half of Romania.

The Scandinavian Anticyclone forms in the Scandinavian Peninsula, most often between 60-70° Northern latitude. Its formation can be explained, on the one hand by the intense atmospheric circulation from North-West of Europe and, on the other hand, by the geographic conditions in Northern Europe.

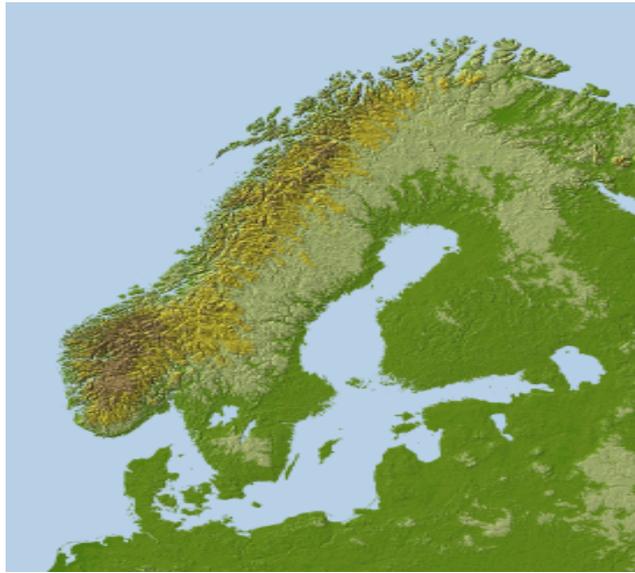


Figure 1. The relief of the Scandinavian Peninsula

In the North-European geographic space there can be met masses of arctic maritime air, coming from the North Pole zone, masses of continental polar air coming from the North-East of Europe, and masses of maritime polar air coming from the Atlantic Ocean. The presence of these air masses with different properties in this area generates cyclonic nuclei. These cyclones cross the Scandinavian Peninsula from West to East. If, at the back side of the cyclone, a well out limited ridge expands at ground level, there can produce a pressure centre with relatively high atmospheric pressure – 1015 – 1020 mb, which will be the initial nucleus of the Scandinavian Anticyclone. If a strong warm ridge is developed over the Scandinavian Peninsula in the troposphere too, the nucleus of the high at ground level will increase and gradually expand.

Unlike other pressure centres on the continent, the Scandinavian High is very mobile. It persists for a short time in its area of formation, moving in about two days along four main directions: to the south-east, to the south, to the east, or, more rarely, to the south-west. The cases in which the Scandinavian High moves to the south-east or to the south, having an influence on the South-East Europe and on the territory of our country represent about 70% of the total number of situations.

The changes in the weather aspect in Romania under the action of the Scandinavian Anticyclone are directly influenced by the position and orientation of the Carpathians. The Carpathian range, being 1600 km long, has three main mountain groups: the North-Western Carpathians, with heights of more than 2500 m in Tatra massif, the Middle Carpathians, which have rarely more than 800 m and have a lot of openings between the main peaks, and the South-East Carpathians, situated mostly on the Romanian territory.

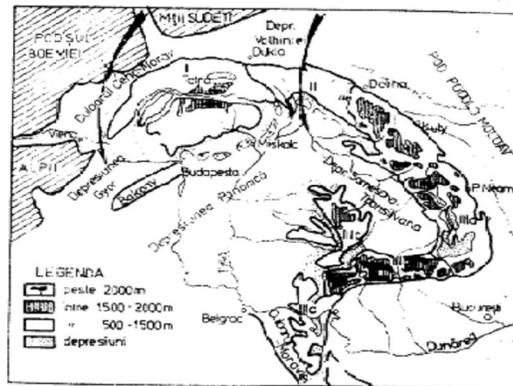


Figure 2. The great geographic divisions of the Carpathians (after V. Mihailescu)

The North-Western Carpathians, with a relatively small horizontal spreading, have a reduced impact on the northern flowing at the synoptic scale. The presence of transversal valleys favours cold invasions. The cold air from northern latitudes can penetrate either in the West, through a plateau area, or in the East, over the Middle Carpathians, filling the Panonian Plateau and reaching the west side of our country, and then, through the Someş „gate” the Transylvanian Plateau. Although the South-East Carpathians have a medium high, they are a complex obstacle in front of air masses.

The position of the Carpathians in our country delimits two large geographic regions: the intra-Carpathian region, inside the range of the mountains, and the extra-Carpathian region, outside the mountain curve, where the influence of these masses of air can be felt more powerfully.

DATA AND METHODS

In order to study the evolution of the Scandinavian Anticyclone there have been used archives of surface and altitude charts, as well as weather data from R.F.C. Timișoara. We have taken into account only the data concerning the area Banat –Crișana, that is the districts of Caraș-Severin, Timiș, Hunedoara, Arad and Bihor.

On analyzing the synoptic conditions for the calendar dates when absolute minimum values were recorded in the period 1961 – 2008, the presence of the Scandinavian Anticyclone was found in most cases.

Thus, for January, the absolute minimum temperature was recorded in 1963. On the 24th of January 1963, in Timișoara the minimum temperature was of -35,3°C. The synoptic analysis shows fact that in the interval 21-24 January 1963, the Scandinavian Anticyclone was formed under the ridge of Greenland High and moved rapidly to the South-East of Europe.

For February, the absolute minimum in Timișoara was of -23,5°C, registered on the 19th of February 1985. The Scandinavian High was formed during that period in the ridge of the Polar High and developed to the South of Europe together with a vast cyclonic area. A similar situation was recorded around the 5th of March 1987, when a minimum of -15,9°C was found in Timișoara.

In April, very low values of minimum temperatures were recorded both in 2002 and 2003. In both cases, occurring about at the same date, the presence of the Scandinavian High was recorded. The absolute minimum in Timișoara for the month of May was of -1°C, on the 13th of May 1978, and it was recorded in the presence of Scandinavian Anticyclone as well, this time being formed in the ridge of the Azores High.

During the summer months, the presence of the Scandinavian High is slighter and its influence area is more limited. But starting with September, its presence can be felt again in our area too. The absolute minimum of $-1,9^{\circ}\text{C}$ in September 1970, and that of $-6,8^{\circ}\text{C}$ in October 1971 were reached also in the presence of the Scandinavian High. During the months of November and December the East-European High is more active and, sometimes, a Scandinavian nucleus is formed under its ridge.

RESULTS AND DISCUSSIONS

In order to show the quick changes that occur in the evolution of weather in the West of Romania, in the presence of the Scandinavian Anticyclone, three cases will be described below. These cases have been chosen in such a way as to emphasize the fact that the cooling caused by the Scandinavian High is, in most cases, a risk phenomenon.

11 -14.02.2004

During this period, the weather was extremely cold, frosty over the night. The Scandinavian High formed under the ridge of the Azores High, spread to the East, after a series of cyclones have crossed the peninsula. In the east of Europe there was recorded a deep cyclone, the through of which gradually spread from North to South, as far as the Aegean Sea. The masses of arctic air move to the South on the back versant of this thalweg.

This synoptic situation is typical for the ultra-polar circulation which causes the most intense cooling. At the level of 850mb, that is about 1500m altitude, a very cold nucleus can be seen, with temperatures of -22°C centred on our country.

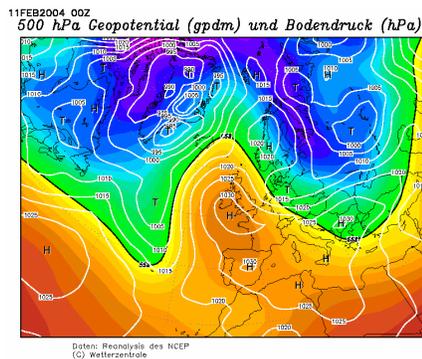


Figure 3. Geopotential at 500mb and pressure on 11.02.2004, h00

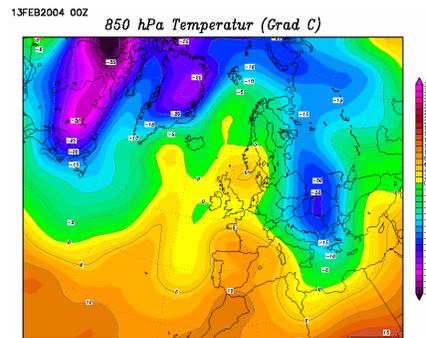


Figure 4. Temperature at 850 mb on 13.02.2004, h 00

On the 11th of February, the minimum temperatures were between -6 and -2°C , normal for that period, and the maximum ones were between -2 and $+2^{\circ}\text{C}$ in Crișana, reaching even 5°C in Banat. It snowed on widespread areas, starting from Crișana, where the snow layer was of 25 cm. The wind blew stronger from the North and there was blowing snow in Crișana. Then, the weather improved as for the precipitations, but the temperatures dropped drastically. Thus, on the night of 12/13.02 the temperatures dropped to -25°C and the maximum temperatures ranged between -9° to -4°C on the 13th of February. But the strong wind made the real temperature, expressed by the wind chill temperature, have values between -20 and -31°C .

The graph in figure 5 shows the evolution of daily mean temperatures in February 2004 and the climatologic mean values for the month of February. It can be noticed that the lowest values of daily mean temperatures were recorded exactly during the period 11 – 14.02.2004.

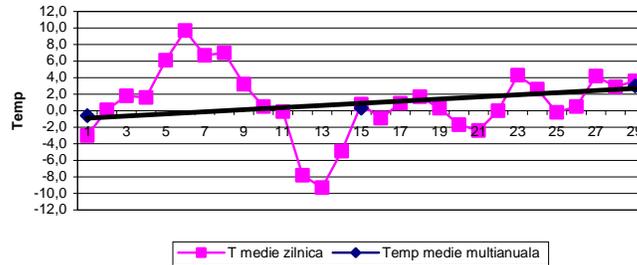


Figure 5. Graph of daily mean temperatures in February 2004, compared to the climatologic mean temperature

05 – 08.04.2003

A ridge of Greenland High spreads to the south-west of Europe and joins the Azores High. This field of high pressure moves slowly to the east and forms a nucleus of 1030 mb that covers the whole Scandinavian Peninsula. Central and East Europe were under the influence of a vast cyclonic field, so that during the period 07 – 08.04 the contact zone between the two pressure centres is exactly over the west of Romania and the air circulation is done on the northern component. The good correspondence between surface and upper air charts can also be seen.

At the level of 850 mb the cold advection is rapidly produced and the isotherm of -10°C covers a large part of Romania.

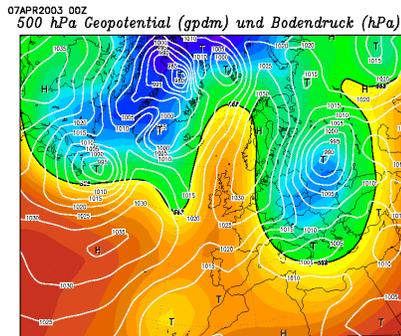


Figure 6. Geopotential at 500mb and pressure on 07.04.2003, h00

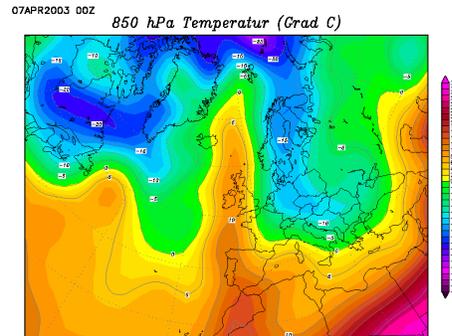


Figure 7. Temperature at 850 mb on 07.04.2003, h 00

The weather became dull and got cold. On the 6th of April, when the west part of the country was on the descendent side of cyclone, precipitations fell, first as rain, then as snow. The snow layer got to 2-3 cm even in the field areas. The wind got stronger and blew the snow. There were rime and frost at ground level on widespread areas. The rime is considered a dangerous phenomenon when it appears after the 20th of March or before 15th of October.

The temperatures dropped with 8 – 10°C as compared to the previous day, so that the minimum temperatures on the 7th of April ranged between -10 and -4°C, and the maximum ones did not exceed 7°C. The graph of daily mean temperatures for April 2003 shows that the coldest days are exactly during the period 05 – 08.04.

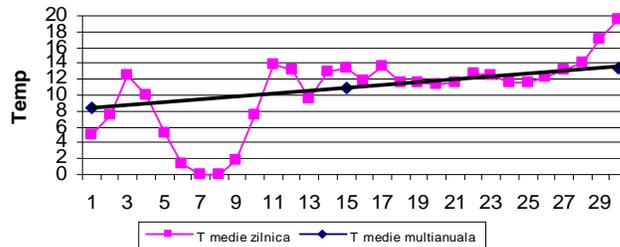


Figure 8. Graph of daily mean temperatures in April 2003, compared to the climatologic mean temperatures.

08 – 11.09.2004

During the first days of September 2004 most part of the European continent was under the influence of a high pressure field, formed by the joining of the Azores High to a ridge of the East-European Anticyclone. Initially its maximum was centred on the ocean, but after the more intense activity of some cyclones in the north of Europe, the high nucleus slowly migrated to the east and centred on the Southern half of the Scandinavian Peninsula. Upper levels we can notice the warm ridge from the west, much spread to the north, and the cold thalweg in the East of Europe. In the area of our country the air flowing becomes northern, both on the surface and upper levels. The temperatures drop rapidly, first in the higher levels of troposphere, then at ground level too. Thus, at the level of 500 mb, that is about 5000 m altitude, the isotherm of -25°C can be noticed, which is characteristic of winter months.

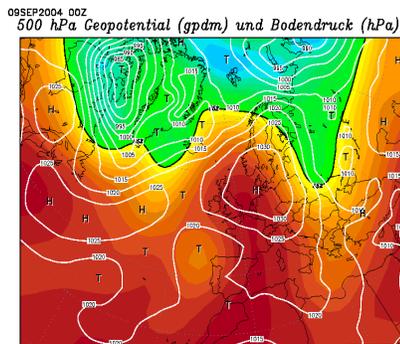


Figure 9. Geopotential at 500mb and pressure on 09.09.2004, h00

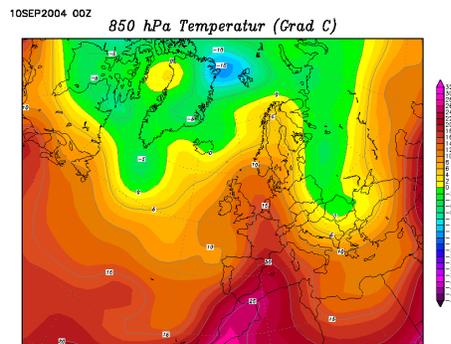


Figure 10. Temperature at 850 mb on 10.09.2004, h 00

In the west of the country the weather was generally fine, but it got cold, starting from Crisana. The wind got stronger from the Northern sector. In the mountain regions there were sleet and snow. The maximum temperatures on the 9th of September were 10-12°C lower than the previous day and during the night of 9 to 10th of September the minimum temperatures were between -2 and +6°C. The following night was cold as well. Here and there, especially in Crisana, there was rime, the first rime of that autumn. The largest negative deviation of the daily mean temperatures occurs during this time, too.

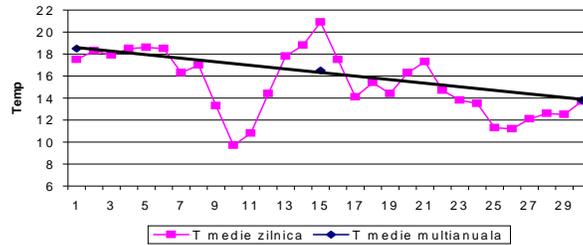


Figure 11: Graph of daily mean temperatures in April 2003, compared to the climatologic mean temperatures.

CONCLUSIONS

The Scandinavian Anticyclone develops as an independent centre only when the cold nucleus from the surface joins a strong ridge in altitude, at least at lower and medium troposphere. It has a great mobility so that, during a period of 24-48 hours we find it at distances as far as 2000 km from the formation area.

If in the South-East of Europe a very active cyclone evolves, the Scandinavian High will remain centred on the north of our country. The strong thermo-baric contrast between the mass of arctic air and that of Mediterranean origin causes unstable weather with heavy precipitation in Muntenia and the South of Moldavia. If the cyclonic nucleus is in the East or North-East of Europe, the Scandinavian Anticyclone will spread to the South-East of the continent, causing a cooling of weather with at least 12-14°C in 24 hours. The changes in the weather condition over the territory of Romania are influenced by the position and the orientation of the Carpathians.

The continental arctic or polar air that moves suddenly from the north of the continent causes, apart from the severe dropping of temperature, a wind increase too, on the predominant northern component. In these situations, during the cold season of the year the snowstorm can occur in the west of Romania. But the frequency of the Scandinavian Anticyclone is greater in spring and autumn, when the severe cooling can lead to the formation of rime or frost on the ground, phenomena that are particularly harmful to agriculture.

So, the Scandinavian Anticyclone is a pressure centre that generates a series of dangerous meteorological phenomena. That is why it is very important to watch its evolution and, if necessary, to send meteorological warning to the areas affected by it.

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