

## THE ANALYSIS OF THERMAL INVERSIONS ON THE NORTHERN PART OF THE SIRET VALLEY

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**Key-words:** thermal inversions, negative vertical thermal gradient  
**Cuvinte cheie:** inversiuni termice, gradienti termici verticali negativi.

### **Analiza inversiunilor termice în partea nordică a Văii Siretului**

Inversiunile termice sunt o stare de stratificare termică a aerului “normală” dacă se are în vedere frecvența ridicată a acestora. Inversiunile termice au frecvență, durată și intensitate mai mare în Moldova și în Carpații Orientali.

În prezenta lucrare, sunt analizate frecvența, durata și intensitatea inversiunilor termice din Valea Siretului dintre Siret și Roman. Sectorul studiat prezintă condiții pentru stagnarea îndelungată și sedimentarea maselor de aer aparținând Anticiclonei Euro-Siberian, mai ales pe timpul iernii. Pe culoar sunt preluate și canalizate circulațiile nordice iar în a doua parte a nopții și în prima parte a dimineții aer rece provenind din zona carpatică prin intermediul vânturilor de munte din cadrul circulației periodice locale de munte-vale. S-a efectuat determinări topoclimatice expediționare în sectorul lacului de baraj Rogojești, în partea nordică a sectorului analizat, acolo unde acoperirea cu stații meteorologice este deficitară. S-a constatat o frecvență medie anuală a inversiunilor termice pe parcursul anului de cca. 20%, cu maximum în ianuarie (peste 30%). Intensitatea medie pe întreg sectorul analizat este de 2-3°C, înscriindu-se în categoria inversiunilor de intensitate medie. Caracteristicile inversiunilor termice din jumătatea nordică a culoarului Siretului influențează temperaturile medii lunare și mai ales pe cele din luna ianuarie, mediile scăzute de la ora 7 în lunile semestrului rece, frecvența mai mare a norilor stratiformi și a ceații în jumătatea a doua a nopții și prima jumătate a dimineții, frecvența mare a fenomenelor de brumă și rouă.

Toate aceste constituie trăsături de bază ale unui topoclimat elementar natural bine definit -culoarul Siretului superior aparținând Podișului Sucevei.

### **INTRODUCTION**

In the troposphere, above any type of active surface and in any climatic zone, the negative vertical thermal gradient and of most of the months is positive, marking the drops of the temperatures at the same time with the growth of the altitude. When the vertical thermal gradient is equal to 0, the air temperature being constant on a certain difference of altitude, the isotherms take place. Any thermal inversion must have above, at the contact with the air stratum with a normal distribution of the thermal gradients, a layer of isotherm, no matter how thin it may be. The inversions in altitude are stopped by this kind of layers of thermal inversion have a big stability so to destroy them and the homogenization of the atmosphere in conditions of thermal, normal thermal stability, huge energies are necessary (Apostol, 2000).

The classical method to determine the characteristics, of the thermal inversions is by making the differences between the temperatures of two weather stations, from the same area, from different altitudes, for a period of time as long as possible.

## **THE VERTICAL THERMAL GRADIENTS IN THE SIRET VALLEY (THE SECTOR SIRET – ROMAN)**

To emphasize the characteristics of the thermal inversions Y used data from weather stations situated at different altitudes: Suceava - 352m, Fălticeni – 348 m, Strunga – 276 m, Pașcani – 248 m, Dolhasca – 230 m, Roman – 216 m, Secuieni – 206 m in the period 1964 – 1998. The analyses also contains differences made for a short period of observation (1998 – 2002) on the basis of the recorded data at the Suceava and Roman weather stations and data obtained from personal research in the sector of the dam of the Lake Rogojești (25 – 30.08.2000) in the Northern part of the analyzed sector, where the covering of the weather stations is poor. Here I have installed three weather observation points: Rogojești (280 m) – on the common in the immediate area of the hydro energetic lake, Vițcani – Deal (400 m) – on the top of the Hill Bour and Vițcani - Bases (340 m) – on the basis of the Hill Bour.

The average annual thermal gradients have values of 0,21°C/100 m after the daily maximum temperature, 0,45°C/100 m after the average annual temperature and 0.76°C/100 m after the daily maximum temperature.

During the year, the average vertical thermal gradient oscillates after the average daily temperature between 0,21°C/100 m in February and 1,19°C/100 m in July. For the hours of weather observations, the most characteristic from point of view of the thermal inversions are between 7 and 13.

In the Siret Valley, at 1 o'clock, the only favorable month for the production of the inversions in the mornings of August, when sometimes, fog is produced.

The vertical thermal gradients of negative sense, indicate the presence of thermal inversions of different intensities all the year, with higher values and frequencies in winter and lower values and frequencies in summer.

The later warning of the lower area is present also during the afternoon, when in spring and in autumn (March – May and August - November) in the low area is colder than in the high area. The situation is perpetuating party during the evening, in March, August and November.

In the valley November imposes as the most characteristic month to produce thermal inversions. On the slopes, March is favorable because on the slopes the snow is in bigger quantities than in the valley, producing frequent spring thermal inversions.

The monthly and annual average vertical thermal gradients emphasize the fact that in most thermal inversions in the Siret Valley are the effects of some coolings in the valley and in a small part of some warnings of the slope areas.

## **THE ANALYSIS OF VERTICAL THERMAL GRADIENTS IN THE NORTHERN PART OF THE SIRET VALLEY**

The analysis of thermal inversions on a short period of observations and through topoclimatic research includes the month of August 2000, for the weather stations Suceava and Roman and the period of 25.08 – 30.08.2000, on the basis of personal recorded data in the Rogojești – Vițcani area after the temperature values recorded at the climatic observation hours 07, 13, 19.

The month of August 2000, there was an average temperature that varied between 19,7°C in Suceava and 21,1°C in Roman. The daily average of the

temperature in the month of August until 15.08 was generally constant in Suceava as well as in Roman, it varied approximately between 18°C – 24°C. After this date, in the second part of the month we can notice, at both stations a growth of the daily average temperatures, recording at the same time the daily maximum temperatures of this month, 35,8°C in Suceava (22.08.2000) and 37,2°C in Roman (21.08.2000) and immediately, beginning with 25.08.2000 a lower of the temperature was recorded to daily average of 11,8°C in Suceava and 13,1°C in Roman, resulting thus a monthly thermal amplitude of 15,2°C in Suceava and 14,8°C in Roman. What is interesting is that this gap of temperature was produced in a small period of days (4-5 days), determined by the dynamics of the air masses, more precisely by the polar circulation from the North of the continent.

As a result of the analysis of the recorded data in the Rogojești – Vițcani area and of its correlation with those from the weather stations from Suceava and Roman, by calculating the thermal differences and the gradients, we could establish a high frequency of the thermal inversions with average intensities.

The calculation of the thermal difference, was made on the basis of recorded data at observations hours 07, 13, 19, in the period 25 – 30.08.2000 between the stations: Roman – Suceava, Roman – Vițcani Deal, Rogojești – Vițcani Bases and Rogojești – Suceava (*figure nr.1*)

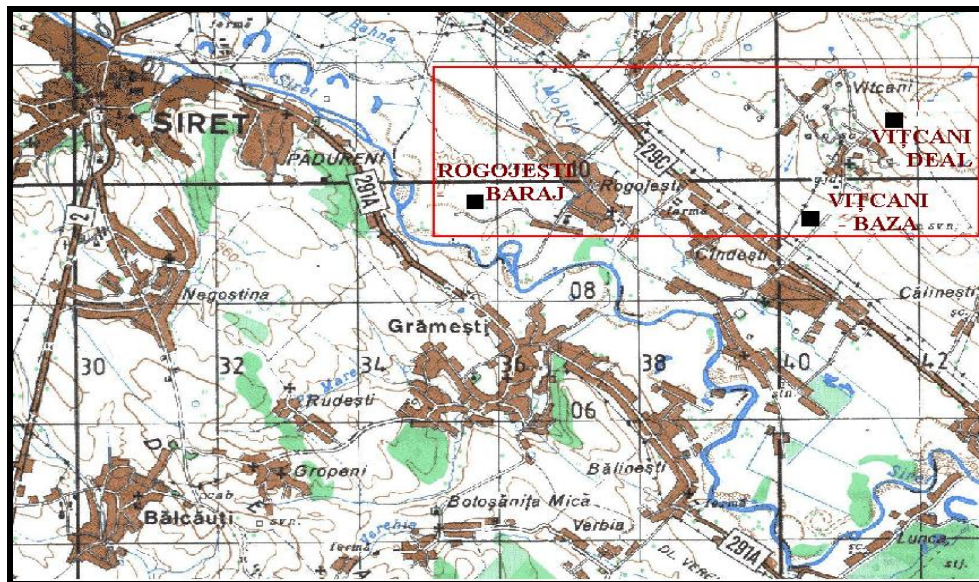


Figure nr. 1: The Northern part of the Siret Valley

As a result of the analysis of these thermal differences we could notice that in the studies period thermal inversions were produced on the whole interval between Rogojești and the point Vițcani-Bază, with 100% frequencies.

In the studies period in the point Vițcani-Deal we could notice that the circulation of the maritime polar air masses indicate a high nebula. From the visual observations, to the frontier the cold and dense air masses circulated unitarily and then after crossing the frontier, they separated into 2 arms, one channeled along the Siret Valley, the other directing towards the East, along Dersca and Lozna, towards the hydrographic basic of Prut river.

In the morning the inversions with the higher intensities take place, the maximum difference of the temperature being of  $-2,6^{\circ}\text{C}$  (Roman – Vițcani Deal at 7 o'clock on 29.08.2000) and in the evening with the lowest intensities (*tabel n<sup>o</sup>1*).

Bigger temperature differences during the morning are due to the radiative cooling the morning are due to the radiative cooling on the terrestrial surface during the night, to better keeping of the air and of the particularities of the relief, existing a passage of the air from the slopes towards the valley.

A particular case is that of the thermal inversions recorded between Rogojești – Suceava and Roman – Suceava, with a frequency of 17% and respectively 11% but only in the evening, at the observation hour 19%. This fact is due to the step loss of the quantity of heat accumulated by the terrestrial surface during the day, fact that leads also to the cooling of the inferior layers of the atmosphere.

In the interval when there were some conditions for a very high frequency of the thermal inversions in the studies area belonging to the Suceava Plateau we can presume that similar processes were produced also in the Rădăuți Depression, area known as having intense frequencies and thermal inversions (Apăvăloaie, M., Apostol, L., Pîrvulescu I., 1987).

Tabel n<sup>o</sup> 1 - Thermal differences at the observation hours 07, 13, 19 ( $^{\circ}\text{C}$ )

STAȚIA	Rogojesti - Vițcani Bază	Rogojesti - Vițcani Deal	Roman - Vițcani Deal	Rogojesti - Suceava	Roman- Suceava
25.08-ora7	-2,2	0,4	0,6	1,1	0,1
-ora13	-0,6	1,4	4,4	0,0	3,0
-ora19	-0,4	2,5	2,7	3,2	3,4
26.08-ora7	-0,4	3,2	1,6	3,0	1,4
-ora13	-1,2	1,6	2,7	1,5	2,6
-ora19	-0,4	1,4	2,1	1,2	1,7
27.08-ora7	-0,6	3,6	1,4	2,7	0,7
-ora13	-0,1	3,0	1,2	2,7	0,9
-ora19	-0,4	0,4	1,0	0,2	0,8
28.08-ora7	-2,2	-1,4	-0,7	1,6	2,5
-ora13	-1,3	0,9	2,0	0,5	1,6
-ora19	-0,8	0,4	1,6	-2,0	0,8
29.08-ora7	-1,2	2,2	2,6	1,0	0,6
-ora13	-0,8	-1,2	-1,0	1,5	1,7
-ora19	-1,2	-0,4	1,2	-1,5	0,1
30.08-ora7	-1,2	0,6	1,0	0,7	1,1
-ora13	-0,8	1,0	1,2	0,1	0,3
-ora19	-1,2	-0,6	-0,6	-0,4	-0,4

In conclusion, the thermal differences of negative sense between the above mentioned places were recorded the entire period 25-30.08.2000, but with relative frequencies that have different values included in three gradual classes:  $-3^{\circ}\text{C}..-2,1^{\circ}\text{C}$ ,  $-2,0^{\circ}\text{C}..-1,1^{\circ}\text{C}$ ,  $-1,0^{\circ}\text{C}..-0,1^{\circ}\text{C}$ . Between the localities of Roman and Vițcani Deal, the thermal inversions with frequencies between  $-1,0^{\circ}\text{C}..-0,1^{\circ}\text{C}$ , have the higher percentage of 16,67%. Between the localities Rogojești and Vițcani Deal we can notice an equality of the weight of two gradual classes of the frequencies of the thermal inversions namely the one between  $2,0^{\circ}\text{C}..1,1^{\circ}\text{C}$  and  $-1,0^{\circ}\text{C}..-0,1^{\circ}\text{C}$  that 11,12%.

Tabel n<sup>o</sup> 2: Thermal frequencies on gradual classe

Punctele de observație	CLASE GRADUALE		
	$-3,0^{\circ}\text{C}..-2,1^{\circ}\text{C}$	$-2,0^{\circ}\text{C}..-1,1^{\circ}\text{C}$	$-1,0^{\circ}\text{C}..-0,1^{\circ}\text{C}$
<b>Rogojești - Vițcani Deal</b>	5,56%	11,12%	11,12%
<b>Rogojești - Suceava</b>	0%	11,12%	5,56%
<b>Rogojești - Vițcani Bază</b>	11,12%	38,89%	50%
<b>Roman -Vițcani Deal</b>	5,56%	5,56%	16,67%
<b>Roman - Suceava</b>	0%	0%	11,23%
<b>Frecvența medie</b>	4,5%	13%	19%

The thermal inversions with frequencies between  $-1,0^{\circ}\text{C}..-0,1^{\circ}\text{C}$  have the higher percentage of 50% between Rogojești and the point Vițcani Bază. In exchange, between Roman and Suceava the thermal inversions with frequencies between  $-1,0^{\circ}\text{C}..-0,1^{\circ}\text{C}$  take place and have a percentage of 11,2% (*tabel n<sup>o</sup>2*).

The average frequency of thermal inversions is the highest, 19% for values from the gradual class  $-1,0^{\circ}\text{C}..-0,1^{\circ}\text{C}$ , being of 13% for values between  $-2,0^{\circ}\text{C}..-1,1^{\circ}\text{C}$  and the lowest frequency for the one from the gradual class  $-3,0^{\circ}\text{C}..-2,1^{\circ}\text{C}$ .

The analysis of the vertical thermal gradients was made on different altitudes according to the position of the existing weather stations, from down to up for the period 25 – 30.08.2000. in this way for inferior altitudes all the thermal inversions from the surface will be discovered in comparison with the stations from higher altitudes, in the slope sectors.

The vertical thermal gradients of negative sense indicate in the studies period the production of the thermal inversions on a percentage of 37%, the rest of the percentage of 63% represents the thermal gradients of positive sense. Between Rogojești and Suceava only one situation of isotherm was recorded at 1 o'clock on 25.08.2000 (*tabel n<sup>o</sup>1*).

According to the recorded values at 7 – 13 - 19 hours, the vertical thermal gradients of negative sense oscillate between  $-0,30^{\circ}$  and  $-5,81^{\circ}\text{C}/100\text{m}$ . From their analysis it results that most of the thermal inversions produced in the evening, when the radiative cooling of the terrestrial surface and especially the influence of the polar circulation generated negative thermal gradients in a percentage of 16% and at the same a high favorable production of the thermal inversions.

In the morning the thermal gradients of negative sense have a percentage of 12%, indicating the production of the observation hour 13, the thermal gradients of negative sense with the percentage of 9% that they have indicate a favorable but lower production of the thermal inversions, due mainly to the radiative heating of the terrestrial surface.

### CONCLUSION

The vertical thermal gradients of negative sense indicate the presence of thermal inversions with different frequencies and intensities that vary in the five groups of points of climatic observation:

a. between Rogojești and the point Vițcani Bază, they have a percentage of 100%, indicating the maximum favorable production of thermal inversions.

b. from the total number of cases, between Roman and the point Vițcani Deal and Rogojești and the point Vițcani Deal, the thermal gradients of negative sense had a percentage of 33% and 23% respectively, indicating the production of thermal inversions of lower frequency.

c. the fewer thermal inversions were produced between Suceava – Rogojești and Roman – Suceava, in the studies period the negative thermal gradients having the lowest percentage of 17% and 11% respectively.

The exclusive analysis of the Northern part of the Siret Valley emphasized a high frequency of thermal inversion, in most cases relative inversions, with reduced time and frequency.

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