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EXTREME WEATHER INTERVAL TYPES IN SUCEAVA: FROSTY AND TROPICAL INTERVALS

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Key words : frosty weather interval, polar circulation, tropical interval, tropical and blocking circulation

Abstract. The amplitude and variability of air temperature in Suceava generates many types of weather and weather intervals during the annual and multi-annual thermal regime. The most frequent ones are specific to the negative thermal extremes of the cold season. Thus, frequency and duration of frosty, polar or subpolar weather intervals are higher than those of the tropical the intervals (which are significantly reduced), being given the northern geographic location of Suceava in Bukovina.
The cold semester is the annual interval characterized by extreme weather events that may approach and sometimes even reach biological discomfort thresholds, endangering social-economic or natural geographic systems. On the background of the current trends of climatic excessiveness, with the increase in frequency of weather episodes with risk events, knowing the evolution conditions of average extreme weather intervals during this particular season is important from both theoretical-scientific and practical-applicable perspectives.

Introduction

Under the current circumstances of climatic evolution, when people speak more of the Earth's atmosphere warming, when weather and climate phenomena reach alarming thresholds in frequency and sometimes magnitude, when in Europe the smooth transition of subtropical climate subzone towards northern latitudes is a common topic, when our country needs to properly manage both climatic resource and dangerous atmospheric phenomena, knowing the typology of extreme weather events and their correct and rapid management is characteristic of a normal in reason and attitude society. When it comes to population health or casualties, it is highly imperative that the consequences of dangerous phenomena must be well known.

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Current climatic realities and climate predictions. According to WMO data, air temperature increased by 10-12°C, from the last Quaternary glaciation (18000-21000 years ago) to 2000 AD (Farcas, Croitoru, 2003); from 1850-1860 to 2000, air temperature increased by +0.6°C on annual average and by +1.0°C in winter months. Only in the twentieth century, the thermal regime of air was higher by +0.8°C, the most important increase being recorded after 1976 (Ivanovici et al., 2003). In the last decade of the twentieth century, air heating was about 1°C, 1998 being the warmest year of the interval 1989-1998.

Provided that pollution rate increases unabated, the 21st century warming will be the most rapid and largest in the last 10.000 years (Ivanovici et al., 2003). For instance, since the beginning of the 21st century, our country has undergone a first record: 2007 - the warmest year in the entire history of meteorological observations in Romania, including Bukovina.

Normally, the Sun follows an activity cycle of 11 years. Current solar cycle, called Cycle 24, should reach its peak soon, but there is no indication (a larger number of sunspots) in this regard. Consequently, some researchers believe there is a possibility that Cycle 25 could not take place. In this case, the impact on the Earth's climate will be significant and we wonder whether or not this decrease in solar activity predicts a second "Maunder Minimum", a 70 years period, which took place between 1645 and 1715 and was characterized by the absence of sunspots. This period was also called the "Little Ice Age".

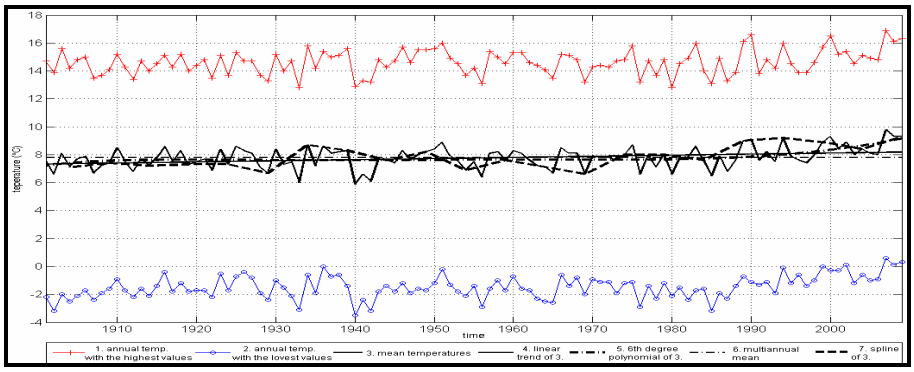

Fig. 1 Annual air temperatures evolution and trends in north-eastern Romania (1901-2009) - after Mihaila and Briciu, 2012

Therefore we unequivocally conclude that the atmosphere in the north eastern Romania undergoes a heating process whose parameters have become more prominent in the last 20-25 years.

The climatic reality of the north-eastern Romania. Using CRU (Climate Research Unit) climate datasets for the 1901-2009 time interval, extracted for 24 locations in north-eastern Romania, several conclusions were drawn.

Annual temperatures (multiannual average temperature in north-eastern Romania = 7.8ºC) increased:

- in the longer term (1901-2009) by approx. 1ºC,
- in the shorter term (after 1980) by almost 1.5ºC,
- and in the very short term (after 2000) by almost 2ºC (Mihailă and Briciu, 2012) - fig. 1, 2

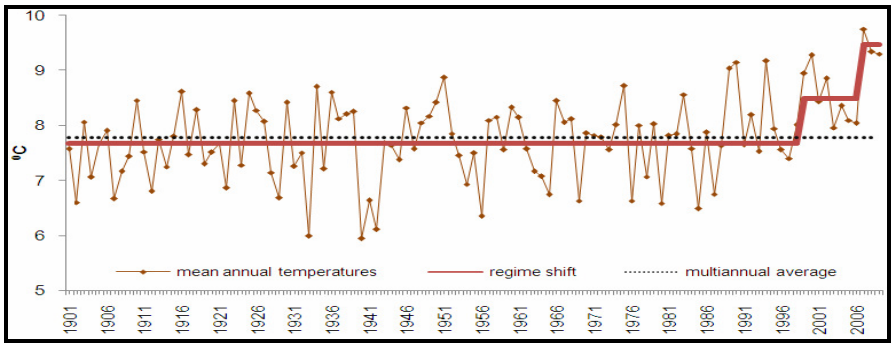

Fig. 2. Evolution of the annual average air temperature values and regime changes compared to the multi-annual average for north-eastern Romania (1991-2009) – after Mihaila and Briciu, 2012

The multi-annual evolution and trends of air temperature in north-eastern Romania followed the same pattern between 1960 and 2010, for all the major altitude zones: mountains, plateaus and hilly plain (Mihaila and Briciu, 2012)

Research location. In order to approach the frequency and duration of the two categories of weather intervals (frosty and tropical), we chose as study area the city of Suceava, located at 47º37' N, 26º14' E, at 352 m elevation - Fig. 3. The two types of extreme weather intervals have drawn attention because of the difficulties generated to biosphere, human body, social and economic system and because of the specific relations developed between different geographic environmental components during their manifestation.

General climate characteristics. To accurately quantify the manifestation parameters of frosty and tropical weather intervals and to situate these weather types in the frame of the general climate of the Suceava Plateau central area, we

should firstly highlight the main climatic peculiarities of the studied location. On the background of transition temperate climate, we note the following:

- Oceanic influences are dominant, but much attenuated by the Eastern Carpathians sheltering effect;
- Continental influences are important, being amplified by the wide opening towards the east;
- Nordic (Scandinavian-Baltic and not only) influences are more pronounced than in other regions of the country, favored by the wide opening to the NW, N, NE and by the orientation of major landform profiles;
- Tropical and subtropical (Mediterranean) influences are very weak from the thermal point of view, but more relevant in what concerns rainfall, due to Mediterranean retrograde cyclones.

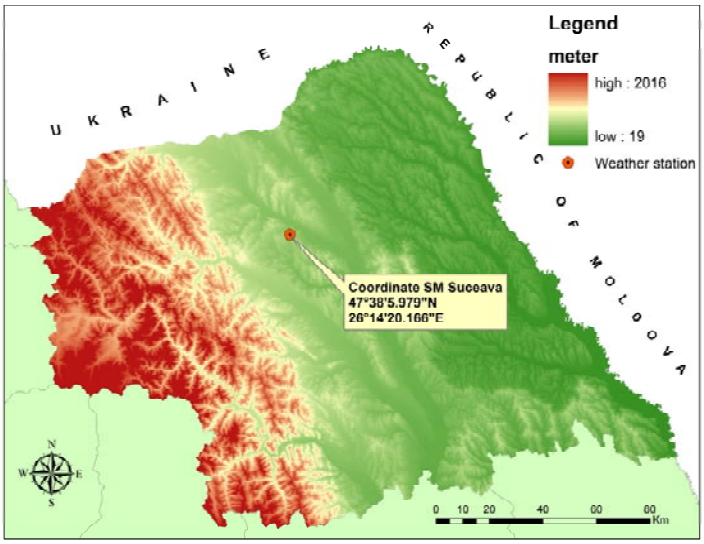

Fig.3. Matematical and geographical location of the study area

Suceava is located in the plateau and low hills climatic altitude zone - Fig. 3, and characterized by an obvious topoclimatic tessellated surface, given by the nature of the active surface within the city and by major landscape features: altitude, slope, exposition. The main quantitative parameters of Suceava climate are found in Tab. 1. Among these, several characteristics of the frosty and tropical weather intervals can be noticed.

Tab. 1 General characteristics of Suceava climate - 1960-2010

Climatic Parameter	January Values	June/July Values	Climatic Parameter
Temperature at the soil surface	-4,6°C	/22,5°C	Temperature at the soil surface
Air temperature at 2m height	-3,9°C	/18,7°C	Air temperature at 2m height
Number of frosty nights (Minimum air temperature ≤ -10ºC)	10,3 nights	-	Number of frosty nights (Minimum air temperature ≤ -10ºC)
Number of winter days (Maximum air temperature ≤ 0ºC)	15,5 days	-	Number of winter days (Maximum air temperature ≤ 0ºC)
Days with air frost (Minimum air temperature ≤ 0ºC)	28,2 days	-	Days with air frost (Minimum air temperature ≤ 0ºC)
Days with soil level frost (Minimum air temperature ≤ 0ºC)	29,9 days	-	Days with soil level frost (Minimum air temperature ≤ 0ºC)
Summer days (Maximum air temperature ≥ 25ºC)	-	9,9/15,2 days	Summer days (Maximum air temperature ≥ 25ºC)
Tropical days (Maximum air temperature ≥ 25ºC)	-	1,3/2,6 days	Tropical days (Maximum air temperature ≥ 25ºC)
Average pressure (hPa)	975,8hPa	972,5/972,9hPa	Average pressure (hPa)
Frequency and speed of NV winds (%;m/s)	25,6%, 5,6m/s	34,2/35,0%;4,9/4,7m/s	Frequency and speed of NV winds (%;m/s)
Frequency of atmospheric calm (%)	34,4%	33,5 / 35,5,4%	Frequency of atmospheric calm (%)
Relative humidity (%)	85%	74/76%	Relative humidity (%)
Cloud cover (tenths)	6,9 tenths	5,9/5,6 tenths	Cloud cover (tenths)
Duration of sunshine	78,5 hours	225,7/246,5 hours	Duration of sunshine
Atmospheric precipitation	22,9mm	98,9/107,7mm	Atmospheric precipitation
Number of days with precipitation ≥ 0,1mm	12,0 days	14,8/14,6 days	Number of days with precipitation ≥ 0,1mm
Number of days with precipitation ≥ 10mm	0,3 days	3,0/3,2 days	Number of days with precipitation ≥ 10mm
Number of days with precipitation ≥ 20mm	-	1,3/0,9 days	Number of days with precipitation ≥ 20mm
Number of days with precipitation ≥ 30mm	-	0,5/0,7 days	Number of days with precipitation ≥ 30mm

Materials and methods. To identify the two categories of weather intervals in Suceava we used hourly temperature data from the Suceava weather station, between 1961 and 2000 (the database included over 350 000 hourly values). Frosty weather interval was defined as the interval in which air temperature is equal to or falls below the threshold of -10°C and tropical weather interval as the interval during which air temperature is equal to or greater than the threshold of 30°C during daytime, and of 20°C at night, respectively.

In what concerns the tropical interval manifested from May to September inclusively, the 24 hours of a calendar day were divided into two periods: the daytime (from 6^{00} to 20^{59}) and nighttime (from 21^{00} to 5^{59}), because we have operated with different thermal thresholds for the two time units ($t \geq 30$ºC and $t \geq 20$ºC respectively). The analysis of tropical weather interval between sunset, evening and first night hours rendered several problems related to the sharp temperature decrease from the 30ºC thermal threshold, at 20^{00}, to the 20ºC threshold, at 21^{00}, at the end of the day, 22^{00} at the beginning of the night and 23^{00} at one hour after the coming of the night. We must underline that the transition from one thermal threshold to another and the radiative-caloric inertia of the active surface (transferred to air layers in the immediate vicinity) causes that in the early night hours of the May-September interval, tropical weather have a significant share, apparently abnormally high.

For both weather categories (tropical/frosty), several parameters were determined: multiannual evolution of the number of days/nights/hours with that particular type of weather interval, time of the year when the weather acquires tropical/polar characteristics, the most representative intervals in which the weather has taken extreme characteristics, as well as favoring synoptic conditions and the impact these weather intervals have on human body, measured by means of bioclimatic indices.

Tropical weather interval

Tropical circulation (according to Topor N. and Stoica C., 1965) has a low manifestation frequency in our country, only 15.0% (which is, on average, 55 days per year). This type of circulation is responsible of producing major climatic risk phenomena in Romania, during the warm season of the year and even in the cold one, with intensity and frequency increasing from the north, from Suceava, Bucovina respectively, to the center and south of the country. This type of southern atmospheric circulation generates in the warm season heat waves accompanied by strong weather heating and often by the occurrence of tropical, canicular days (with temperatures of 35-40°C) and tropical nights (nights in which the minimum temperature does not fall below 20°C). Tropical weather can also occur during blocking circulation with a generally eastward movement, when extremely hot continental air directly influences weather characteristics in Moldova, including its northern part.

During nights, from May to July, the number of tropical weather hours gradually increases, followed by its decrease in values until September inclusively (Fig. 4).

In the central part of Suceava Plateau (as in any other point on the northern temperate sub-zone map), after sunset and until morning, intense heat loss

determines a gradual decrease in the number of hours with tropical temperatures, both monthly (Fig. 5a) and throughout the entire warm period of the year (Fig. 5b).

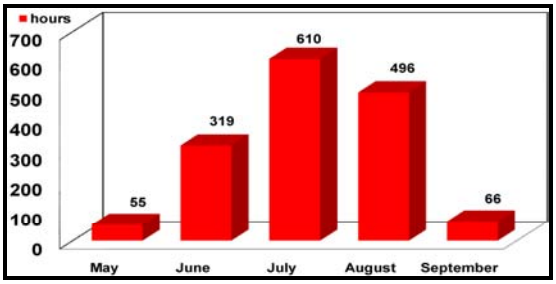

Fig. 4 Inter-monthly nighttime evolution (21^{00} to 5^{00}) of the number of hours with temperature ≥ 20ºC in Suceava (1961-2000)

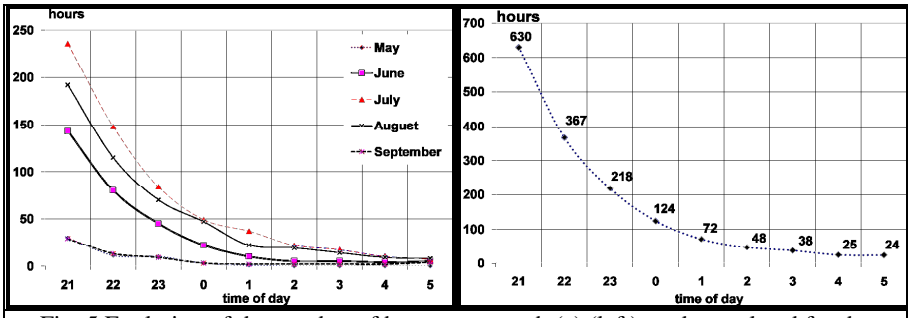

Fig. 5 Evolution of the number of hours per month (a) (left), and cumulated for the period May -September (b) (right), in which weather shows thermal tropical characteristics in Suceava (1961-2000) for the hourly interval 21^{00} to 5^{00}.

If in the evening, after sunset, the frequency of tropical weather intervals reaches its maximum, in the morning before sunrise, such intervals are rare (Fig. 5a, 5b).

We also considered for analysis and comparison the number of hours with air temperature ≥ 20°C between 6^{00}-20^{00} [which according to the chosen criteria are only partially included - hours with air temperature ≥ 30ºC - in the category of tropical hours (Tab. 2 and Fig. 6) in order to have a real perception on the distribution of this weather type for the two time divisions (night/day) that constitute a calendar day.

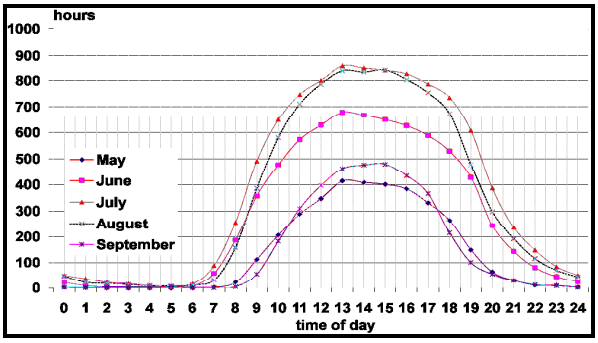

Fig. 6 Evolution of cumulative number of hours with air temperature ≥ 20ºC, for the period May to September and hourly interval 1^{00}-24^{00}, in Suceava (1961-2000)

Tab. 2. Cumulative number of hours (separated in hourly intervals and months) with air temperature ≥ 20°C (with tropical weather at night and warm weather during daytime) in Suceava (1961-2000)

	Cumulative number of hours during the nights in which air temperature was ≥ than 20^0C (tropical weather)									Cumulative number of hours during daytime in which air temperature was ≥ 20^0C												
Hours	***21***	***22***	***23***	***24***	***1***	***2***	***3***	***4***	***5***	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
May	30	11	10	3	1						3	22	112	206	288	347	414	408	401	384	331	264	149	64
June	143	80	45	24	10	5	5	4	5	7	58	187	357	477	573	628	678	667	649	626	588	529	428	244
July	236	148	84	50	37	22	17	10	7	16	88	256	491	649	747	801	857	849	840	826	787	735	607	387
August	192	115	70	44	22	19	14	9	8	12	31	158	386	581	710	787	838	833	841	804	754	673	478	298
September	29	13	9	3	2	2	2	2	4	2	1	5	55	183	309	397	462	476	479	434	366	215	100	55

Of considerable interest is the analysis of tropical night time weather intervals based on a number of cases with different durations (Fig. 7 and Tab. 3). From the last spring month until July, the duration of tropical weather episodes increases, followed by decrease until September. If in May tropical weather intervals last 3-4 hours after sunset, in July they may be extended and sometimes reach the first moments of the next day sunrise. Unlike May, for September statistics show (Table 3) an increased frequency and duration of nighttime tropical weather interval.

However, tropical night time weather is only 1.17% of the time between sunset and sunrise. This value allows us to state that in Suceava summer nights rarely display tropical thermal characteristics.

During May-September daytime interval, the 30ºC thermal threshold is rarely exceeded. Cool climate of the high Suceava plateau is therefore validated by this thermal parameter.

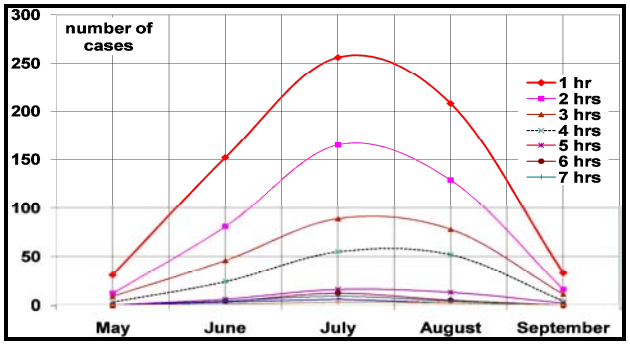

Fig. 7 Inter-monthly evolution (May to September) of the number of cases with tropical weather inter- vals of different duration (from one hour up to 9 consecutive hours) during evenings / nights (21^{00}-5^{00}) in Suceava (1961-2000)

Tab. 3. The number of cases with tropical weather intervals of different durations (from one hour up to 9 consecutive hours) for the months May to September in Suceava (1961-2000)

Numberof cases	May	June	July	August	September
1 hr	31	102	256	208	33
2 hrs	12	81	165	129	16
3 hrs	9	46	89	78	11
4 hrs	3	24	55	52	4
5 hrs		6	16	13	2
6 hrs		4	12	5	
7 hrs		4	9	4	
8 hrs		3	6	2	
9 hrs		1	3	2	

In the warmest years, during warm season days, tropical weather intervals amounted to no more than 60 hours (eg. 1992, when 60 hours with temperatures ≥ 30°C were recorded in Suceava - Fig. 8).

The days of august (Fig. 8 - inset) have the most favorable synoptic conditions for approaching and exceeding the 30ºC thermal threshold.

Overall, from May to September, tropical temperatures have a negligible temporal share (476 tropical hours, compared to 143.208 hours with temperature below 30ºC - Fig. 9). We could say that tropical weather during daytime has a much lower (0.33%) share compared to that in the evening and during nights (1.17%).

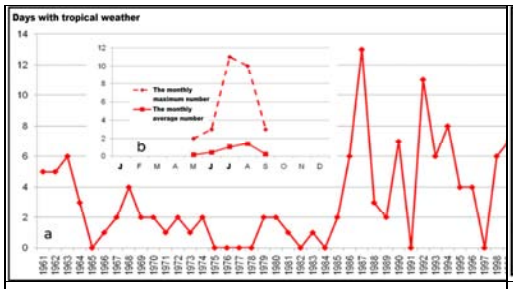

Fig. 8 Annual and multiannual evolution of the number of hours with temperature ≥ 30°C in Suceava (1961-1999)

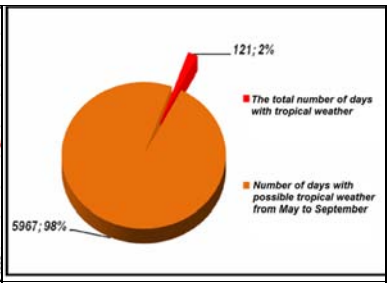

Fig. 9 The effective number and percentage share of the total day hours when air temperature was ≥ 30°C in Suceava (1961-2000)

Even if in Suceava tropical weather occurs episodically (1.5% in one year), high temperature intervals are a characteristic of the climate of this location that cannot be disregarded.

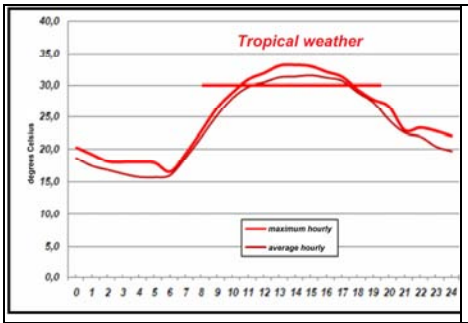

Fig. 10 a Inter-hourly evolution of equivalent effective temperature values in Suceava, between 8 and 11 August 1992

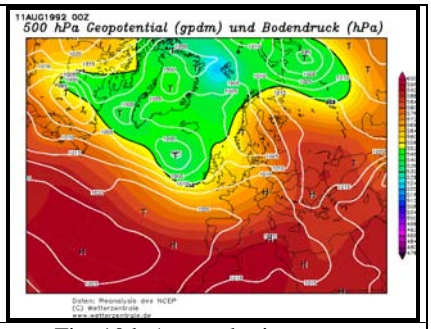

Fig. 10 b Atmospheric pressure distribution on the ground and at the 500hPa isobaric surface over Europe on 11 august 1992, at 0^{00}GMT

During their manifestation human body is in an obvious thermal discomfort, crops, plants and animals suffer because of humidity, rainfall and hydrologic deficit.

Anticyclonic synoptic conditions are those which favor the occurrence of tropical weather intervals.

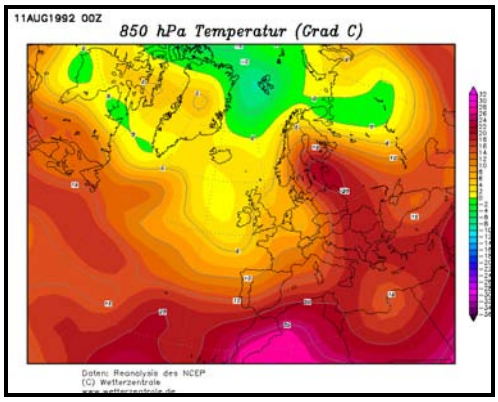

Fig. 10c Air temperature distribution at the 850hPa isobaric surface over Europe, on 11 august 1992, 0^{00} GMT

We opted for two of the cases of tropical weather episodes: one belonging to the last decade of the 20^{th} century. - Fig. 10a-c, and the other that belongs to the first decade of the 21^{st} century.

Between 8 and 11 August 1992, our country, such as the whole Europe, was during for 4 days and 4 nights under the influence of a high pressure anticyclone field, extended from the active surface level to middle troposphere (at the 500hPa isobaric surface pressure, values increased above normal - Fig. 10b). Warm, dry air mass formed under stability conditions of tropical and continental anticyclones at temperate latitudes favored insolation and occurrence of temperatures exceeding 15ºC at the upper part of the lower troposphere (the 850hPa isobaric surface - Fig. 10c) over our country, even at the 2^{00} official time.

Under these circumstances, the equivalent effective temperature increased during noon hours over the 30ºC threshold - Fig. 10a, thereby indicating pronounced thermal discomfort experienced by the inhabitants of Suceava city.

Another period to which we refer is the canicular interval from July 2007, which covered the whole country, affecting a large part of the population, especially in the plains and hills of the southern and eastern parts of the country. This period was uncomfortable even in the Romanian north-eastern plateau area.

Average hourly values during 16 to 22 July 2007 were situated within the discomfort limits because of the heat of over 21ºC and equivalent effective temperature of almost 28º EET (Teodoreanu and Mihaila, 2012). Even during night hours, before sunrise, at 4^{00}, when the average daily minimum temperature for the above mentioned period was recorded, the effective temperature felt by the human body actually exceeded the comfort limit.

Between the hourly interval 7^{00} to 9^{00} and 18^{00} to 20^{00} of June-August, there may be days and nights (singular or grouped) when the temperature and humidity index values exceed the 80 units threshold, at which point the body enters a state of discomfort.

Weather intervals characterized by heating discomfort, under conditions of high atmospheric humidity, can pose significant problems to the overall socio-economic system or human individual in particular. They are however very uncommon in Suceava.

Frosty weather intervals. They are usually determined by the anticyclonic regime installed during the cold season or by north, north-eastern etc. sector advections (polar circulation which accounts for 30.0% during the year, according to Topor and Stoica, 1965). Polar circulation generates harsh winters, early and late frosts, cool summers. Arctic air invasions are often followed by stability intervals and under favorable physical-geographical conditions (depressions, valleys) and snow layer , they generate very intense over-cooling.

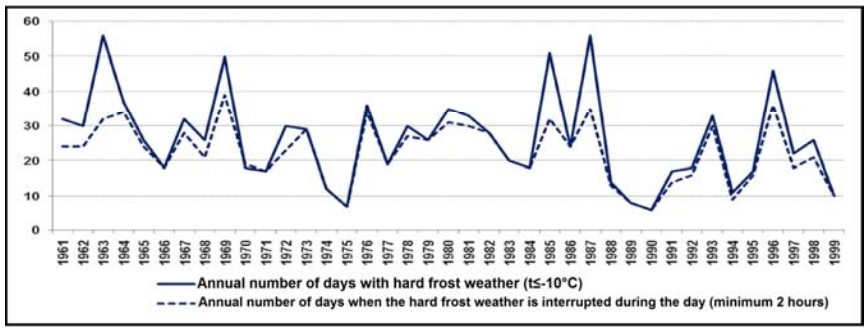

Fig. 11 Multi-annual evolution of the number of days with frosty weather in Suceava (1961-1999)

Frosty weather interval, defined as the interval with air temperature equal or below ≤-10ºC, was analyzed by means of several parameters. We considered a frosty weather day the 24 hours particular time interval (between the hours 1^{00} and 24^{00}) during which for at least one hour air temperature was ≤-10ºC. In the

central part of Suceava Plateau, in winter days, frosty weather sometimes continuously extends during daytime. But most often, around noon or afternoon, frost intervals are interrupted for short times. Therefore it seemed relevant to consider as well the number of days with frosty weather interrupted for at least 2 hours during the day, these intervals marking a certain improvement of the atmosphere thermal parameters - Fig. 11.

For the years with cold seasons characterized by air temperature values above seasonal average, the number of days with frosty weather is low (i.e. between 1989 and 1990 - Fig. 11). For the years with cold seasons that have temperatures below seasonal average, the number of days with frosty weather can exceed the threshold of 50 (i.e. 1987).

Within a year, frosty intervals occur in Suceava from November to March inclusively. The coldest months of the year are January and February - Fig. 12a and b. In most cases, frosty weather night hours are interrupted during daytime, provided that temperatures rise above -10ºC for at least 2 hours (12.b).

Multi-annual evolution of cumulative duration in hours of frosty weather and its deviation from the multi-annual average in Suceava, for the 40 years analyzed (1961-1999), shows great variability (Fig. 13).

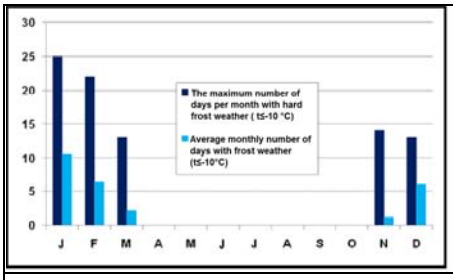

Fig. 12a Inter-monthly evolution of the maximum /average monthly number of days with frosty weather in Suceava (1961-1999)

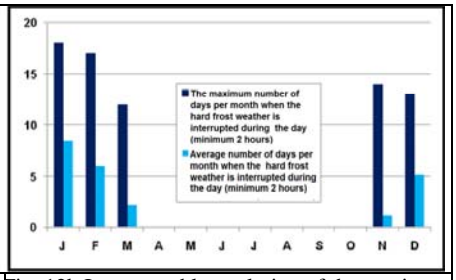

Fig. 12b Inter-monthly evolution of the maximum /average monthly number of days in which frosty interval is interrupted during daytime for at least 2 hours in Suceava (1961-1999)

One can differentiate three cases that coincide with the cold intervals of the year, between 1962 and 1964, 1967 and 1969, 1985 and 1987, where frosty weather significantly exceeded the multi- annual average, but also singular situations with persistent frosty weather during the cold semesters 1972-1973, 1976-1977, 1993-1994 and 1996-1997. January holds the most frosty weather record, of over 5000 hours in 40 years.

In some cold semesters or winter months, frosty weather intervals were insignificant or small, while in others reached a maximum of over 300

consecutive hours (about 12 days), both as cumulated or maximum effective duration (Fig. 14a and b) and as percentage (Fig. 15 a and b).

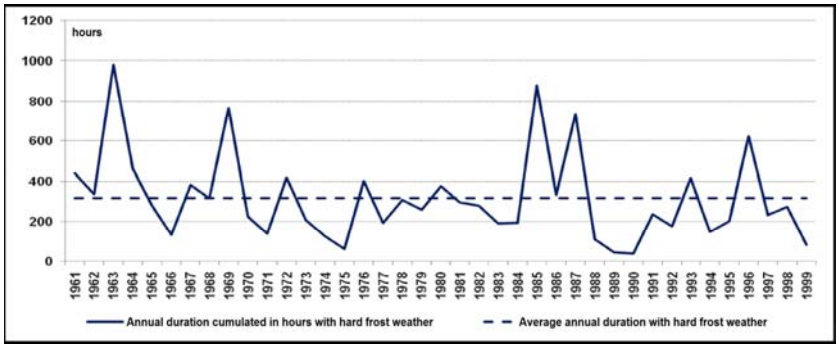

Fig. 13 Multi-annual evolution of cumulative duration in hours of frosty weather intervals and their deviation from the multi-annual average in Suceava (1961-1999)

An interesting case study for the frosty weather analysis in Suceava is the interval between 10.01 and 1.02. 1963. Its length (23 days and nights with frosty weather) and frost amplitude (the lowest thermal minima were between -17 and -23ºC; hourly thermal averages of the interval ranged between -13 and -16.3°C), make this frosty weather interval most suitable for rendering more accurately a climatic feature of Bucovina winters: prolonged periods of intense frosts.

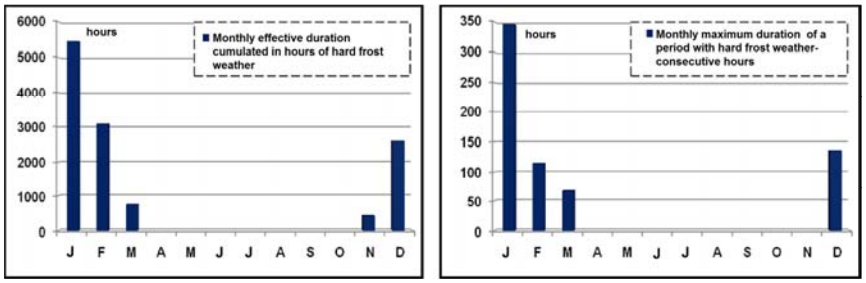

Fig. 14. Cumulated total monthly duration in hours (a) (left) maximum duration in consecutive hours (b) (right) of frosty weather intervals in Suceava (1961-1999)

During this interval, high atmospheric pressure fields dominated over the earth's surface above the north-eastern Romania - Fig. 16b, fueled by the core of the anticyclone positioned over the south-western Scandinavian extremity.

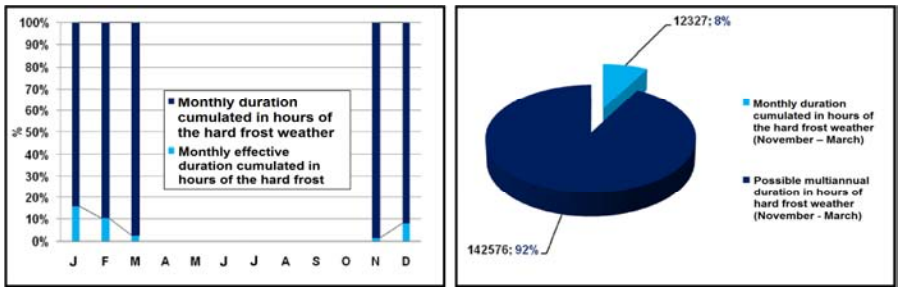

Fig. 15. Cumulated or effective monthly duration in percenta (a) (left) şi multiannual cumulated or possible durations (b) (right) of frosty weather intervals in Suceava (1961-1999)

A large, cold, low pressure air volume was positioned over the east - south-eastern extremity of the Scandinavian anticyclone Ridge from the ground, so that the air temperature was very low to the middle troposphere - for example at the 850hPa isobaric surface temperature above northeastern Romania was below -20°C - Fig. 16c. Such intense and prolonged frosts are hardly bearable by the population, often causing mortality in vulnerable groups: the elderly, children, sick people etc.

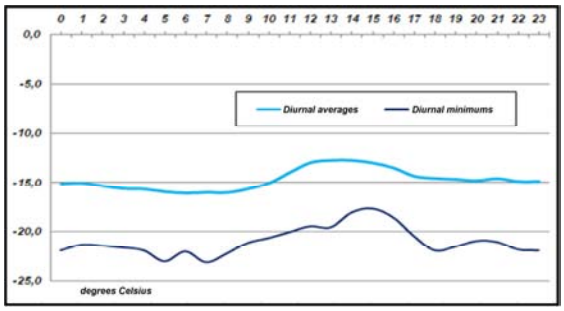

Fig. 16a Diurnal evolution of hourly average and Minimum temperatures between 10.01 and1.02. 1963 in Suceava

For very cold, windy periods, skin stress index can reach higher values of wind cooling capacity, resulting in a very high hypertonic stress, with implications on the health of those exposed.

On January 23rd, 2006 at 8 and 9 a.m., wind cooling power increased to 1752, 1768kcal/m^2/h respectively. Such values can quickly cause frostbites on human body parts unprotected and exposed to direct atmospheric air.

For shorter time intervals, the temperature equivalent to wind cooling power (TPR) can reach very low values. For instance, on January 23rd, 2006 at 8 and 9 a.m., when air temperature dropped to -24 and -23.2°C and wind speed reached 8 to 9m/s, TPR showed -46.5 and -47.2ºC respectively.

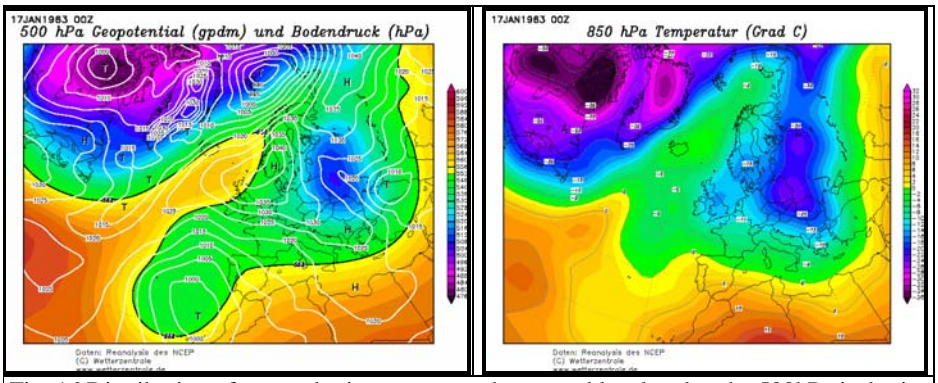

Fig. 16 Distribution of atmospheric pressure at the ground level and at the 500hPa isobaric surface (b) and air temperature at the 850hPa isobaric surface (c) above Europe on January 17, 1963 at 0^{00}GMT

These thermal values perceived by the human body as being very low, are similar to low temperatures of Siberia or Antarctica. Although such values of TPR are rare, they occur under severe winter circumstances. Such episodes, identified with the help of TPR, show that in Suceava Plateau, cold thermal stress to which human body is subjected reaches its maximum during heavy winters (cold and windy).

Conclusions

The frequency and intensity of tropical/subtropical weather intervals are insignificant for Suceava climate when compared to the frosty/polar (Scandinavian-Baltic) influences.

Tropical weather intervals, by means of their frequency and parameters, do not pose special problems to human body and socio-economic activities during the warm season.

The risk to which human body is exposed is considerably higher for the frosty weather intervals, compared to the tropical ones. In the cold season additional protection measures ought to be taken, especially for vulnerable people.

The conclusions resulting from these synthetic studies lead to a net differentiation between the climatic events characteristic of the two main

seasons, warm and cold, as well as to a fair appreciation of the often contrasting and contradictory weather conditions evolution.

A strong need emerges from this study, that of knowing and taking into account for the socio-economic activities the results of the studies performed on these phenomena. Sustained, closer interdisciplinary collaboration is also required, where climatologist researchers should have knowledge and global understanding of the trends of weather and climate evolution in a particular location, trends that can be negative with respect to certain human components.

Bibliography:

Fărcaş I., Croitoru Adina-Eliza (2003), *„Poluarea atmosferei şi schimbările climatice”,* Casa Cărţii de Ştiinţă, Cluj-Napoca.

Mihailă D., Briciu A.-E. (2012), *„Actual climate evolution in the NE Romania. Manifestations and consequences”,* 12th International Multidisciplinary Scientific GeoConference, SGEM2012 Conference Proceedings/ ISSN 1314-2704, June 17-23, 2012, Vol. 4, 241-252 pp -http://sgem.org/sgemlib/spip.php? article2277

Slavic Gh. (1977), *„The plateau of Suceava – Climatologic study, doctorate thesis – manuscript,* **U.C.L.** Iaşi.

Tănasă I., Mihăilă D, (2005), „*A few aspects about some phenomena of climatic risk from the cold period of the year in Suceav*a”, Collection of papers “The weather, the climate and the durable development”, Bucharest, **I.M.N.A.**, September, 28th – 30th.

Tănasă I., Mihăilă D., Budui V. (2006), *„Consideration about the white frost and freezing phenomena in Suceava”,* Seminarul Geografic “D. Cantemir” Nr. 26 / 2006

Teodoreanu Elena, Mihăilă D. (2012), *„Is the bioclimate of Suceava Plateau confortable or uncomfortable? Analysis based on TEE and THI”,* Present Environment and Sustainable Development, Vol. 6 no. 1/2012, Pages 205-218, http://www.pesd.ro/Pesd%20vol%20%206%201%20-%202012.html

Teodoreanu Elena , Mihăilă D. (2012), „*Is the bioclimate of Suceava Plateau confortable or uncomfortable? Analysis based on wind cooling power index and skin and lung stress index”,* Present Environment and Sustainable Development, Vol. 6no. 1/2012, Pages 229-251, http://www.pesd.ro/Pesd%20vol%20%206%201%20-%202012.html

Topor N., Stoica (1965), „*Tipuri de circulaţie şi centri de acţiune atmosferică deasupra Europei”,* C.S.A., Institutul Meteorologic, Bucureşti

***** (1961-2000)** – *The monthly meteorologic tables* ***MMT*** *from the Suceava Meteorologic Station*

******* www.wetterzenrale.de

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