CONSIDERATIONS REGARDING THE VARIABILITY OF EARTH-SUN GEOMETRY AND THE CLIMATE VARIABILITY IN SOUTH-WESTERN ROMANIA

I. MARINICĂ[1], ANDREEA MARINICĂ[2]

Abstract. Considerations regarding the variability of Earth-Sun geometry and the climate variability in south-western Romania. The variability of the Sun-Earth geometry is particularly high during the year due to the specific trajectory of the planet Earth around the Sun, the rotation motion of the Earth around its axis, the inclination of the rotation axis with respect to the plane of the ecliptic and the axis of precession. As a result, the variability of the duration of days (and nights) occurs on Earth and the amount of energy received by the Sun varies continuously. Corresponding to these variations in correlation with the characteristics of the Earth's surface and the general circulation of the atmosphere on the Earth, large climatic variations occur which determine at the temperate and polar latitudes the succession of the antipedes. All these variations are reflected in the great climatic variability of one year. In this paper we analyze in detail the variability of the Earth-Sun geometry and its correlation with the climatic variability in southwest Romania (Oltenia). The conclusions are useful for weather forecasting and seasonal climate forecasting as well as those interested in climate variability.

Key-words: Earth-Sun geometry variability, climate variability, Earth's thermal equator, polar climate front.

1. INTRODUCTION

Earth is the third planet from the Sun in our solar system. Its movement around the Sun is particularly complex[3]. It is performed in the direct trigonometric sense (as opposed to clockwise or "counterclockwise"). The annual movement of the Earth around the Sun is called **the revolutionary movement**. A complete rotation around the Sun takes 365 days 6 h 9 min. 9 s., a value that underlies the definition of the sidereal year. Because the orbit has an ellipse shape, the Earth, during the year, is at points closer or farther from the Sun. Thus, in January the distance between Earth and Sun is 147 million km, this position being called perihelion.

[1]Ph. D. S.R. II, Associate Professor, Faculty of Science, Department of Physics, University of Craiova., ionmarinică@yahoo.com.

[2] Jacobs University Bremen, marinica.andreea@gmail.com.

[3] The variable position of the Earth on its trajectory, in relation to the Sun, is called the **Earth-Sun geometry**. A rotation around the axis of the earth leads to the apparent sunrise and sunset of the sun, moon, stars and day-night changes. A full rotation of the Earth around the axis, 360 degrees, takes 23 hours, 56 minutes and 4,091 seconds.

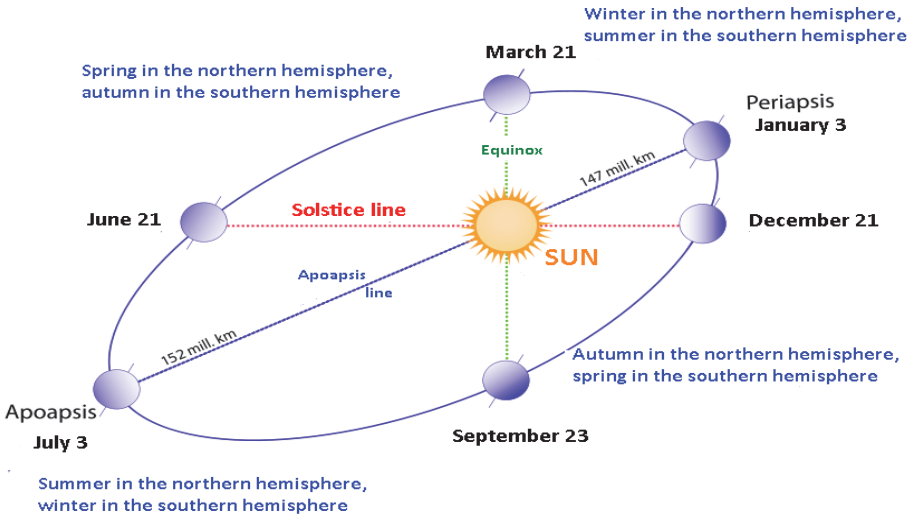

Fig. 1. The trajectory of the Earth's movement around the Sun. (after: https://commons.wikimedia.org/w/index.php?curid=36949173)

In July, the Earth is at the largest distance from the Sun of 152 million km. This point is called ***aphelion. Depending on the year, the date of the perihelion may vary from 1 to 7 January, while the date of aphelion may vary from 2 to 6 July***[1]**.** The difference of the vector rays between that of the aphelion and that of the perihelion is about 5 million kilometers. An average distance of approximately 150 million kilometers is maintained between the two celestial bodies. The Earth's trajectory is an ellipse (Fig. No. 1). The value of its large semiaxis was used when defining the astronomical unit considered equal to 149,597,870,700 meters. The real orbit of the Earth in space is called **the ecliptic**. The movement of the Earth around the Sun respects Kepler's laws (1609, 1619):

- **Law I**, **of the elliptical orbits**: the planets move around the Sun on the elliptical trajectories, the Sun being in one of the foci.

- ***Law II*** (1609): The Sun-Planet vector ray describes equal areas in equal times (ie has constant areolar velocity[2]), consequently the velocity in orbit differs; the planet moves faster in the vicinity of the perihelion and slower in the vicinity of the

[1] The Earth is at the greatest distance from the Sun in summer in the northern hemisphere around July 3, (aphelion) and at the shortest distance around January 3 (perihelion), when it is summer in the southern hemisphere. The Earth travels faster when it is closer to the Sun, which is why **winter is about 5 days shorter than summer in the northern hemisphere, and in the southern hemisphere summer is shorter.**

[2] ***The areolar velocity*** is the size of the area described by the vector radius of the Earth in the unit of time. The vector radius of the Earth is the vector that unites the center of the Sun with that of the Earth (meaning Sun to Earth).

aphelion[3]. The astronomical data regarding the speed of the Earth on the trajectory around the Sun are: Vmed≈29,8 km/s, Vmin≈29,3 km/s (at aphelion), max≈30.3 km/s (at perihelion).

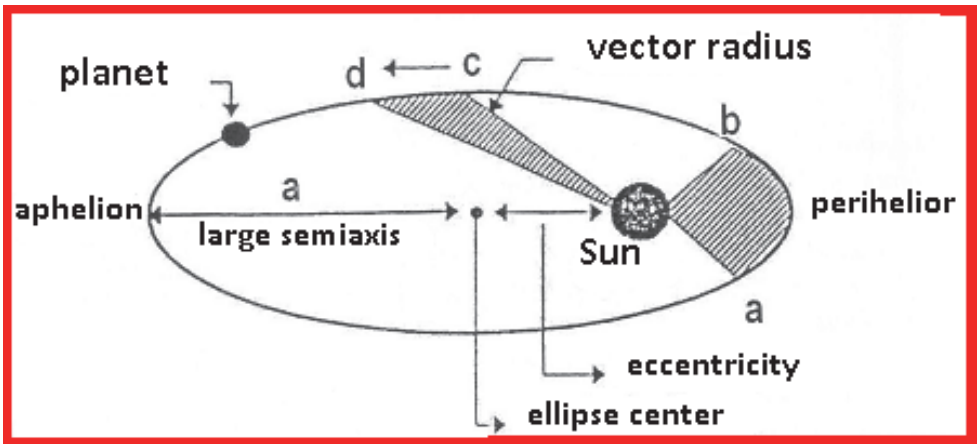

Fig. 2. Illustration of Kepler's second law.

- Law III. (1619) The revolution periods of the planets around the Sun (T) and the large semiaxes of the orbits (a) are related by the relation T^2/a^3= constant (the squares of the revolution periods are inversely proportional to the cubes of the large semiaxes of the orbits or average distances from Sun). The law of periods can also be formulated as follows: The ratio between the square of the period of motion and the cube of the large semiaxis has a constant value for all the planets of the solar system.

Consequence: The duration of a revolution around the Sun increases with distance from the star.

We will analyze further how the variability of the Sun-Earth geometry for Oltenia is reflected (calculations are performed for the coordinates of the weather station in Craiova (44°19`N; 23°52`E)) and the correlation with the mean, minimum and maximum values of the air temperature in Oltenia. For northern or southern latitudes the variations are different. At the North Pole, during the warm season in the northern hemisphere (astronomical range March 21-September 23) is the polar day, and at the South Pole is the polar night and vice versa. The succession of seasons is produced by the precession movement and the inclination of the Earth axis of 23.5°. ***Summer*** comes north of the Equator when this hemisphere is inclined towards the Sun and in ***winter***, respectively, when it is inclined in the opposite

[3] ***At aphelion***, the Earth's speed on the trajectory is 7000 km/h, lower than in the perihelion. The average temperature of the Earth increases by an average of 2.3°C during the aphelion.

direction to the astral. ***The precession movement*** is the movement of the axis of rotation of the Earth and due to it the line of equinoxes moves slowly and retrogrades along the ecliptic producing the precession of the equinoxes. The variability of the Earth-Sun geometry determines the continuous variability of the days and nights due to the variability of the sunrise and sunset times. As a result of Kepler's law, ***the boreal spring*** (austral autumn), is from the equinox in March to the solstice in June and has 92.7 days; ***the boreal summer*** (austral winter) is from the solstice in June to the equinox in September and has 93.7 days; ***boreal autumn*** (southern spring) is from the September equinox to the December solstice and has 89.9 days, and ***the boreal winter*** (saustral summer) is from the December solstice to the March equinox and has 89.0 days. The amount of energy received from the Sun on a given area on the Earth's surface varies continuously.

2. DATA AND METHODS

To carry out the work we used the NMA data archive, the climate data maps and the databases. The astronomical data were those presented on the website of the Astronomical Institute of the Romanian Academy as well as the calculation program of the sunrise and sunset times at the latitude of the central part of Oltenia (corresponding to the weather station in Craiova (44°19`N; 23°52`E)). The data of the variability of the Earth-Sun geometry are variable from year to year, and the calenadristic data from the work related to them are average caledaristic data.

3. RESULTS AND DISCUSSIONS

3.1. Variability of the Earth - Sun geometry in December and its consequences on the climate in Oltenia.

In December at the average date of 21.XII the winter solstice[4] takes place, and the Earth's thermal equator is positioned in the southern hemisphere and its displacement towards the south continues. The winter solstice marks the beginning of astronomical winter[5]. The polar vortex[6] expands and the intensity of air circulation within it increases. As a result, cold air “detachments” occur from the polar zone, which travels south in the form of subpolar cyclones which later become cyclones of the temperate latudines, of cold talwegs that transport the cold air to the south and gradually determine the installation of winter. Due to the cooling of the air throughout the northern hemisphere, there is the development of the huge

[4] Production dates for solstices and equinoxes are not constant, varying with one day more or less than the average data.

[5] In the winter solstice the angle made by the sun's rays with the horizontal plane at noon is the lowest of the year, the sun is just above the Tropic of Capricorn. The variation of this angle during the year is due to the fact that the axis of rotation of the Earth is not perpendicular to its orbit.

[6] The speed of the polar vortex is higher (and more extensive) in winter and usually weakens in summer or even disappears in some time intervals.

anticyclonic field that stretches over some periods of time throughout Eurasia and rapidly brings cold Arctic and Siberian air throughout Europe. Its cold air ridges, which sometimes extend south, transport cold air to southern latitudes.

Data on Earth - Sun Geometry in December (variable from one year to another with an extra day or less), shows that in December there are 2 days with decreases of 2`, 16 days with decreases of 1`, 6 days with decrease 0` and 7 days with increases of 1`. At 1.XII the sun rises at 07:40 and sets at 16:47 (OIR[7]), so the duration of the day is 9h07`. At 6.XII the sun rises at 07:46 and sets at 16:46, so the duration of the day is 9:00. On 7.XII the sun rises at 07:47, and sets at 16:45, so the duration of the day is 8:58, thus recording the first decrease in the duration of the day under 9 hours. On 18.XII the sun rises at 07:55` and sets at 16:47`, so the duration of the day is 8h52` (equal to that of 25.XII). From 19.XII to 24.XII the duration of the day[8] is 8h51` (ie 57.0% of the maximum duration of the day from the summer solstice thus produces "Sole statio"). At 21.XII the sun rises at 07:57, and sets at 16:48, so the duration of the day is 8:55, and the winter solstice is produced. On December 23, it is time for the Sun to reach a degree in Capricorn. On 25.XII the sun rises at 07:59 and sets at 16:51, so the duration of the day is 8:52, (the same as in 18.XII, so the first increase of the day is recorded 1 minute after the winter solstice [9]).A new astronomical cycle of nature begins. On 31.XII the sun rises at 08:00` and sets at 16.55`, so the duration of the day is 8:55` (equal to that of 11.XII). *The decrease in day's duration* in December is 16 minutes (the smallest intermonthly decrease of the whole year). *During the astronomical autumn* (21.IX-21.XII) the decrease of the day's duration is 3h15`. *The smallest average decrease of the day's duration appears in December*. In December the duration of the day is kept <9 hours for 25 days (in the range 7-31.XII). The duration of the day reaches again (slowly increasing) 9 hours only on January 5. It follows that in the interval 7.XII-4.I the duration of the day is <9 hours, for 30 days. records decreases of the day duration of 2 minutes, in 16 days decreases of 1 minute, in 7 days of 0 minutes and in 11 days increases of 1 minute. The earliest sunset time of the Sun is 16:45 and occurs for 6 days between 7-12.XII, then the Sun sets later but rising and rising later, the sunrise approaching 08:00. *The latest sunrise is 08:00* and occurs for 13 days, between 27.XII-8.I, and starting with 9.I, the sun starts to rise more and more early. Thus, the shortest days of the year are recorded in December. ***The maximum difference between night and day duration during the winter solstice is 378 minutes (6 hours and 18 minutes) and records in five days: 19, 21, 22, 23 and 25.XII***. Due to the short duration of insolation and the climatic processes that produce throughout the northern hemisphere (discussed above), at Oltenia's point

[7] OIR = winter time of Romania

[8] At more northern latitudes, the daytime duration is much shorter, for example at 51 ° 27′N during the day, during this time it is 7 hours and 51 minutes.

[9] The observation is valid for a large part of the northern hemisphere except for the area north of the polar circle.

of view, the monthly average temperature decrease from November to December is Δt = -4.9°C (average temperature decrease from December), ***it is the last major drop in temperature from one month to another during the year*** and marks the entry into winter (the first winter month); The thermal extremes of December recorded over time in Oltenia are: ***The absolute maximum thermal for Oltenia*** is 21.6°C recorded in Polovragi (Gorj county) on 4.XII.1985; ***The absolute minimum temperature*** for Oltenia is -28.5°C registered in Strehaia (Mehedinți county) on 16.XII.1948. ***The maximum air temperature amplitude*** in December is 50.1°C.

3.2. Variability of the Earth-Sun geometry in January and its consequences on the climate in Oltenia.

In January ***at the average date of 3.I Earth is perihelion*** on its trajectory (the minimum distance from the Sun), and the Earth's thermal equator is positioned in the southern hemisphere on average, at the maximum southern limit of its displacement[10], after this once, depending on the conditions of circulation throughout the planet, its displacement slowly changes to the north. *The polar vortex* expands and the intensity of air circulation within it increases. Further "detachments" of cold air from the polar zone are moving southward as subpolar cyclones that later become cyclones of temperate latitudes, cold talwegs that transport cold air southward and gradually bring winter in the northern hemisphere. Due to the cooling of the air throughout the northern hemisphere, the development of the huge anticyclonic field that stretches over some periods of time throughout Eurasia brings the Arctic and Siberian cold air quickly throughout Europe. Its cold air ridges, which sometimes extend south, transport cold air to southern latitudes. ***January is the peak month of winter***[11] for the entire northern hemisphere, and during this month the lowest temperature minima have been recorded, which are actually the absolute minimums during the year. In January-February, the snow layer reaches in most years the maximum extension and thickness on the northern hemisphere. *Data from the Earth - Sun geometry in January*, for Oltenia shows that: there are 14 days with ***increases of 1`,*** of which the first 8 consecutive (1- 8.I), 13 days with ***increases of 2`*** and 4 days with ***increases of 3`.*** At 1.I the sun rises at 08:00 and sets at 16:56, meaning the duration of the day is 8h56`. On 31.I, the Sun rises at 07:44 and sets at 17:33, meaning the duration of the day is 9h49`, so it doesn't reach another 10 hours. Therefore, in January, ***the increase of the day's duration is 53 minutes***, with a daily average of 1`43``, it is the ***first major increase*** of the day's duration in a month. This increase in the length of the day makes its effect "felt"at the end of January and the beginning of February as well as throughout the course. In January between 1-4I, the duration of the day is <9 hours, for 4 days. On the 5th of the day it reaches 9 hours. In January for 8 days, between

[10] **The southern limit of the displacement of the thermal equator** varies from year to year depending on a multitude of factors.

[11] Most commonly, the maximum air cooling occurs in the interval 15.I-15.II.

1-8.I the sun rises constantly at 8, and starting with 9.I the sunrise occurs before 8. Starting with 9.I, in the process of increasing the duration day-to-day increases occur ≥ 2 minutes[12]. On 17.I ***the first increase of the year, of the day of 3 minutes***, occurs and the duration of the day reaches 9h16`. From the ones discussed above it follows that near the solstices the variations of the day duration are small ("time does not rush") and as you can see further near the equinoxes (before and after) the variations of the duration of the day are large (2-4 minutes) ("time is rushing"). This is the effect of Kepler's Law II which increases the speed of the Earth on its trajectory near the equinoxes and decreases the speed near the solstices. As a result of the variation in the amount of heat received from the Sun in the air circulation, rapid changes occur, in the transitional seasons, due to the acceleration of the synoptic processes by increasing the amount of energy. In the extreme seasons, summer and winter, the changes are slower and the time more stable due to the small variations in the length of the day, which determines a slower pace of the atmospheric processes. The consequence is that weather forecast models also give more stable results over time. At the latitude of the central part of Oltenia (Craiova) the maximum variation of the duration of the day from one day to another is 4 minutes (such values being recorded near the equinoxes). At higher latitudes the variations are greater, and in the area of polar circles the variations are null because we have on average 6 months polar day and 6 months polar night.

When the Earth is at the perihelion, the northern hemisphere is oriented in the opposite direction to the Sun receiving from it the smallest amount of energy throughout the year. Air cooling north of the polar circle reaches the lowest values (frequently below -50.0°C). As a result, during the first 7 days of January in the northern hemisphere, ***cold waves*** are frequently recorded that determine the lowest minimum temperatures (the so-called "Epiphany frost" occurs, considered in the popular tradition the harshest winter frost. ***The second interval of January in which there are intense cold waves*** is the range 23-28.I and sometimes these cold waves are more intense than those of the first part of the month. We exemplify the intense cold wave that on the night of 24/25. I.1942 caused the lowest temperature values in January to be recorded in many countries in Europe, many of these records have remained unclassified to this day.In this interval (3-26.I) ***the Earth's thermal equator reaches the southernmost limit of extends into the southern hemisphere*** (southern Africa). ***The polar climate front of the northern hemisphere reaches its southernmost position in the southern Mediterranean and northern Africa***. Arctic (A) and polar (P) air masses dominate most of Europe. The precipitations are are in the form of snow and the snow layer in some years, reaches the maximum extension and thickness (except for warm winters). In Oltenia, the monthly average temperature drop from December to January is $\Delta t = -2.7°C$ (lower average January temperature), is the last temperature drop from one month to another during the

[12] In popular language it is said that "the day is crossing" (cut a furrow from the field of time, or it is said: "from the Epiphany, the day is crossing").

year and marks the peak of winter. (the second winter month); The average temperature in January for Oltenia is -2.8°C, for Romania the average temperature in January is -2.1°C. So January is colder in Oltenia than average for the whole country, but Moldova is the coldest region.

The thermal extremes of January in Oltenia are:

The absolute maximum temperature for Oltenia is + 20.6°C recorded at Tg. Jiu (in Gorj county) on 29.I.2002 and at Calafat (Dolj county) on 30.I.2002; ***The absolute minimum themperature*** for Oltenia is -35.5°C at Craiova (the value was recorded at Craiova AVIASAN weather station located in Balta Verde in the lower part of the city near Lunca Jiului, on the road to Podari commune) registered on 25.I.1963 (Dolj County). This temperature value is an absolute thermal ***record for the Romanian Plain. The maximum amplitude*** of the air temperature in January is 56.1°C.

3.3. Variability of the Earth-Sun geometry in February and its consequences on the climate in Oltenia.

The main data resulting from the variability of the Earth-Sun geometry in February are the following:

On 1.II. The sun rises at 07:43 and sets at 17:34; that is, the duration of the day is 9h51. On 28.II. The sun rises at 07:04 and sets at 18:11; that is, the duration of the day is 11h07`. ***So the day's increase during the month of February is 1h16`***, which ***means a daily average of 2`42``.*** On 20.II The sun sets at 18, and after this date it will rise after 18 (O.I.R). In February there are 12 days with increases of the duration of ***2 minutes*** (not all consecutive as the other days with increases), 9 days with increases of ***3 minutes*** and 7 days with increases of ***4 minutes***. It is the first month of the year in which there are increases of 4 minutes. As a result of the gradual increase in the length of the day, the slow rise of air temperature in the northern hemisphere occurs and triggers the climatic process of charging. Therefore, during the winter from the date of the winter solstice to the end of February, the increase in duration of the day is ***2 hours and 13 minutes***. At the end of January and the beginning of February, the Earth's thermal equator begins to move slowly to the north and as a result major changes in the air circulation occur on Earth. At the level of the northern hemisphere, the ridge of the East-European Anticyclone is slowly retreating to the east. The huge anticyclonic field that predominates in January is fragmented, the ridge of the Azoric Anticyclone begins to expand at some intervals over Europe, and the warm air masses over the Atlantic and northern Africa are becoming more frequent over Europe bringing intervals with time. warm and rainy days given by the Mediterranean Cyclones, which are becoming more active and more frequent. The snow layer begins to melt and hydrologically begins to flow more abundant water which causes melting and breaking the ice on the rivers. Extended warm periods occur with thaw on the ground, which causes the slow recovery of the vegetation stages from the vegetal carpet and the autumn agricultural crops. On some days, rainfall is liquid or mixed.

The polar climate front is slowly starting to retreat north. Cold polar and sometimes arctic air advancements reach some days in northern Africa, causing dust hoses to be produced, which are taken up by air circulation and brought far north over Europe. Usually in February the monthly minimums are recorded in the first part of the month, and the maximums in the last decade or even in the last peak of the month. The monthly average temperatures register the first increase during the year, and in Oltenia are between -2.5°C in Voineasa and 0.9°C in Dr. Tr. Severin, and the average for the entire Oltenia region (including the mountain area) is -0.8°C. The first increase in average temperatures during the year compared to January was recorded, rising between 1.8°C in Polovragi and 2.2°C in Calafat, Băileşti, Caracal, Craiova, Slatina and Tg. Jiu. The monthly average increase in air temperature for the entire region compared to January is 2.0°C. ***The absolute minimum temperature of February is -31.0°C*** registered in Strehaia in 1950. A very low value is -28.9°C registered in Băileşti (Dolj County) on 1.II.2012. Monthly thermal minimums are usually recorded in the first part of the month. ***In some years, in the first 15 days, February is just as cold as January or even colder[13]. The absolute maximum temperature of February is 24.2°C recorded in 2016 at Bechet,*** in the hottest February in the history of meteorological observations, (value only 0.8°C lower than the thermal maximum of a summer day). A value close to this was 24.0°C recorded on 16.II.1899 at Dr. Tr. Severin and that until 27.II.1995 (for 96 years) was the absolute maximum thermal for the entire country of February. Other close values were: 23.8°C recorded on 13.II.2002 in Calafat and Bechet on 27.II.1995.

3.4. Variability of the Earth-Sun geometry in March and its consequences on the climate in Oltenia.

The following data results from the variability of the Earth-Sun geometry: At 1.III the day duration is 11h10`, and at 31.III the day duration is 12h42`, ***so the increase of the day during March is 1h32`***, ie an ***average daily of 2`58``*** (the highest daily average of growth during the year). The equinox occurs on 20 or 21.III (most commonly on 20.III). At the time of the equinox all the hours on Earth correspond to the time zone. In the Northern Hemisphere, the astronomical spring begins, and in the Southern Hemisphere the astronomical autumn. At the North Pole starts the polar day, and at the South Pole the polar night; the polar day lasts 178 days, and the polar night lasts 187 days (with 9 days more, which contributes to the cooling of the atmosphere in the cold season); in March, at the latitude of Oltenia there are ***5 days with increases of 2`, 19 days with increases of 3`*** (of which

[13] As proof is also that the ***absolute minimum temperature in Romania is the value of -38.5 ° C, registered in Bod (Braşov County) on the night of 10 / 11.II.1929 as well as on the night of 24 / 25.I.1942.***

7 days are consecutive) and ***7 days with increases of 4`***[14] (this month there is the highest number of days with increases 4 minutes each) After 2.III the sun rises before 7. At around 25.III the day starts at summer time, due to the increase of the day duration in the northern hemisphere, especially in the last decade of the month starts the air temperature to rise: normally the monthly minimums of temperature are registered in the first part of the month, and the maxima in the last part, frequently in the last pentad. In March there is a second increase in the monthly average of temperature during the year. *The average monthly temperature increases* in March compared to the last winter month (February) are between 4.3°C at Tg. Logresti and 5.6°C in Caracal, and the increase of the general monthly average, calculated for the entire region, is 5.0°C, ***being the first big increase of the average monthly temperature during the year***, thus confirming the arrival of spring and announcing that the hot season will follow. ***The general average temperature***, ***for the whole region, is 4.2°C, registering an increase of 5.0°C compared to February*** and in many areas with more than 5°C (for example in Bâcleş the increase is 5.4°C). ***The absolute minimum thermal temperature in Oltenia is -27.0°C recorded at the Apa Neagră on 5.III.1987***, ie a specific value for January or February. ***The absolute maximum monthly temperature in March is 29.5°C recorded at Dr. Tr. Severin*** in western Oltenia in 1927, confirming the spectacular and rapid temperature jump after the spring equinox. March is thus the first month of the year[15] in which thermal maximums are recorded ≥25.0°C (ie days specific to the summer season[16]).

3.5. Variability of the Earth-Sun geometry in April and its consequences on the climate in Oltenia.

On 1.IV, the sunrise at 07h06` and sets at 19h 52`, so the duration of the day is 12h46`. On 30.IV, the sunrise at 06h17` and sets at 20h27`, and the duration of the day is 14h10`. It turns out that in April ***the monthly increase in the day's duration is 1h24`***, ie with a ***daily average of 2`48``*** (10 seconds lower than the average increase in March). There are ***8 days*** with increases in duration of ***2 minutes, 16 days*** with increases in duration of ***3 minutes*** and ***6 days*** with increases in duration of ***4 minutes***. Therefore, it is usually the largest interlunar increase in the day's duration after March, throughout the year. ***During the two spring months (March and April), the length of the day increases by 2h56` (with almost three hours), which largely explains the rapid coming of spring process for the entire northern hemisphere.*** The multiannual monthly averages in April are between

[14] The calculations show that no increase or decrease in the day's duration at Oltenia's latitude is greater than ***4`***.

[15] March is the first month of the year in which in Romania the air temperature can reach and exceed 30°C (32.8°C at Odobesti in March 1952 and 30.8°C at Constanta).

[16] The day when the maximum air temperature is ≥25°C is called a "summer day" (cf. meteorological terminology).

7.7°C in Voineasa and 12.0°C in Bechet, and the monthly average for the entire region is 10.4°C, registering an overall increase compared to March of 6.2°C, which is the second interluneal increase of March. temperature (***the highest throughout the year***). In some areas the growth is higher than 6.2°C as for example in Bechet where the growth is 6.4°C. ***April 2018 was the hottest in the entire history of climate observations*** (after monthly averages and deviations from normal). ***The monthly average for the whole Oltenia*** in 2018 was ***15.8°C which is the absolute climatic record*** for the entire observation period (1894-2018). April is particularly capricious in terms of thermal regime, and the low temperatures and late mists, as a consequence can occur in some years even on the last day of the month. ***The absolute maximum temperature is 35.5°C registered at Bechet on 10.IV.1985 and which is the absolute maximum temperature for the whole country, meaning a value of heat*** and thus exceeding the old absolute maximum of April of 33.5°C registered in 1909 in Calafat. After 76 years, therefore, we have a jump with 2.0°C of maximum temperature values in April. On the same day (10.IV.1985) a maximum temperature value, almost as high, 35.1°C was registered in Băileşti. April is thus the first month of the year when the air temperature can reach and exceed 35°C. At the same time, the date of 10.IV, just 20 days after the spring equinox, signifies the first day of the year in which the canicle may appear in Romania. ***The absolute minimum thermal temperature of April in Oltenia is -8.6°C registered in 7.IV.2003 at Tg. Logresti***, confirming the trend to overtake the thermal extremes in both directions. And in April, there was an increase in monthly thermal minimums. Thus, low values close to the one mentioned, but higher, were recorded in Voineasa: -6.0°C on 2.IV.1965, -5.9°C on 5.IV.1970, -5.6°C on 12.IV.1996 etc. confirming the global warming for April. Usually the monthly thermal minima are registered in the first decade of the month, but the increase of the climatic variability has determined the registration of the monthly thermal maximums in some years in the first decade, and the monthly minimums in some years have been registered on calendar dates located in the middle of the month or even in the last decade or so, for example -3.2°C at Tg. Logreşti are logged in on 29.IV.1984. *The absolute amplitude of the air temperature in April in Oltenia is 44.1°C.*

3.6. Variability of the Earth-Sun geometry in May and its consequences on the climate in Oltenia.

At 1.V, the sunrise is at 06h16` and the sunset at 20h28`, so the duration of the day is 14h12`. On 31.V, the sunrise was at 05:44 and the sunset at 21.01, so the duration of the day is 15h17. It follows that in ***May, the monthly increase in the day's duration is 1h15`***, ie with a daily average of 2`25``. From 22.V to 22.VII the day duration is ≥15 hours (for 62 days). From 22.VII to 23.VIII (for 33 days) the star Sirius rises and sets with the Sun, an aspect called ***the astronomical canicle***, (from the canicula = puppy, the name of the star Sirius). So during one year, the ***hot season starts with 22.V and ends at 9 IX or even 15.IX lasting 117 days***. The

popular holiday called *Moşii de Vară* (which is celebrated on 26.V, with the first small increase in the duration of the day of 1 minute) signifies the beginning of the warm season in the popular tradition. In May there are ***3 days with increases of 1 minute*** (starting with 26.V), ***21 days with increases of 2 minutes*** (of which 11 days are consecutive in the interval 15-25.V) and ***7 days with increases of 3 minutes***. It is the first month after the months of February, March and April in which no day is recorded with increases of 4 minutes. On 26.V there is the first increase of the duration of the small day of only 1 minute after the months of February, March and April, which means that the summer solstice is close.

The average monthly temperature ranges from 12.1°C in Voineasa to 17.5°C in Bechet. High values ≥17.0°C are recorded in the southern half of the region: 17.0°C in Craiova, 17.1°C at Dr. Tr. Severin and Caracal 17.3°C in Calafat 17.4 in Băileşti and 17.5°C in Bechet, and the highest in the extreme south. *The multiannual monthly average of the air temperature* calculated for the entire Oltenia region with the values on all the relief steps and data from the long-range weather stations, in May, is 15.4°C, registering *an average increase of 5°C* compared to April, being the third great temperature increase (≥5.0°C) during the year after the March and April temperature rise, foreshadowing the arrival of warm summer weather. This large increase in temperature plays an important role in the rapid development of vegetation phases for the entire plant carpet (foliage development, flowering, fruiting, growth of shoots, initiation of ripening processes in some species and generally the impetuous development of biotopes). We note that although the average monthly values in May and April are different, the increase in air temperatures in the Oltenia Plain and the southern Getic Piedmont is constant registering a 5.5°C leap over a wide area, an aspect due to multiple causes including: massive displacement of hot air due north to the entire northern hemisphere, on the one hand due to the much northerly advancement of the Earth's Thermal Equator and on the other the increase in the duration of insulation and the change in atmospheric circulation types, etc. *The absolute maximum temperature* [17]*of May in Oltenia is 39.6°C recorded in the extreme southeast of Oltenia, in Corabia on 27.V.1950*. Also at that time were recorded: 37.7°C in Leu, 38.0°C in Caracal, 37.5°C in Tg. Jiu, and in Calafat 36.5°C in 1908. The monthly maximums are usually recorded in the last decade of the month. We note that the exceptional thermal maximums of the month recorded in the last peak of the month of May in the middle of the last century have remained unclassified until now. *The absolute minimum thermal temperature of May in Oltenia*[18] *is -3.2°C recorded at Apa*

[17] The absolute maximum monthly temperature of May for Romania is 40.8°C ***registered at Mărculeşti in Bărăgan on 27.05.1950***, thus being the first month of the year in which, in Romania, the air temperature can reach and exceed 40°C.

[18] The absolute minimum monthly temperature of May in Romania is -9.6°C registered on the night of 14/15.05.1940 in Câmpulung Moldovenesc, being the last month of the year in which the thermal minima in our country can decrease below -10°C.

Neagră on 6.V.2011, but in May 2011, except for three weather stations (-0.2°C at Tg. Logreşti and -1.4°C at Voineasa, and in the mountain area -5.1°C at Ob. Lotrului) the monthly minimums were positive. To this date, the absolute minimum temperature of May is -2.8°C recorded at Baia de Arama in 1909, and in the mountain area -6.8°C at Parâng in 1944. ***During the calendar spring the increase in the day's duration is 4 hours and 11`, and the increase of the seasonal average of the air temperature compared to the last winter month is 16.2°C. During the astronomical spring (21.III-21.VI) the increase of the duration of the day is 4 hours and 27`.***

3.7. Variability of the Earth-Sun geometry in June and its consequences on the climate in Oltenia.

At 1.VI the sun rises at 05:54`` and sets at 21:02``, ie the duration of the day is 15h18`; is the first day of the year with an increase of 0 minutes. ***The maximum duration of the day throughout the year*** is 15h32` and is recorded in 3 days: 19, 20 and 24.VI. The duration of 15h31` is recorded for 8 days, ie in the dates of: 16, 17, 18, 21, 22, 23, 25 and 26.VI. ***So for 12 days the day duration is ≥15h31`***. The day registers an increase between 1 and 24.VI, of 14`, then a decrease of 4` between 24.VI and 30.VI, consequently in June the monthly increase of the day's duration is only 12`. ***The minimum duration of the day in June is 15h and 16`*** and is recorded only on 1.VI. ***On 21.VI (most frequent) or 22.VI the summer solstice is produced, and the duration of the day is 15h31`. The maximum difference between the duration of the day and the duration of the night during the summer solstice[19] period is 424 minutes (7 hours and four minutes) and is recorded in three days: 19, 20 and 24.VI, exceeding by 46 minutes the maximum difference between the duration nights and days during the winter season.*** This inequality of the two differences shows a significant asymmetry in favor of the summer season compared to the winter season. From the date of 21.VI the decrease of the duration of the day starts with a single fluctuation of growth of 1 minute on the date of 24.VI. In June there are ***14 days without increasing or decreasing the duration of the day*** (with 0 minute increments), ***7 days with 1 minute increase, 3 days with 1 minute decreases*** starting with 21.VI. and ***a 2-minute drop***.

The monthly averages in Oltenia are between 12.1°C Voineasa and 17.5°C at Bechet in the southern extremity. *The monthly average temperature* for the whole region is 18.4°C, registering an increase of 3.5°C compared to May. *The average monthly temperature increases* in June compared to the last spring month - May,

[19] In astronomy, solstices are called the two moments of the year when the plane determined by the center of the Sun and the axis of rotation of the Earth is perpendicular to the plane of the orbit of the Earth. In the two moments of the year the angle made by the sun's rays with the horizon at noon is the highest (at the summer solstice) or the smallest of the year (at the winter solstice). This time is the beginning of astronomical summer; and when the meridian passes, the Sun rises above the horizon at the maximum angle.

are between 1.5°C at the Apa Neagră and 3.8°C in the extreme south of the Oltenia Plain at Bechet. In most of the Oltenia region the average temperature increase is relatively uniform, varying by only 0.1°C from one area to another, and the increase of the general monthly average for the entire region is 3.5°C, ***being the third increase in ascending order after the one between March and February and April-March***, which shows a "softening" of the increase of the air temperature in the first summer month compared to the last month of the spring, also signifying the high degree of heating of the air in the last month of the spring season. In June, the astronomical longitude of the Sun is 90 degrees, entering the zodiac sign of Cancer. The sun is therefore at 23 degrees and 27 minutes maximum angular distance to the north of the celestial equator), the maximum absolute values of temperature for the whole year are not recorded in June but in July and August. ***The absolute maximum thermal temperature of June in Oltenia is 42.0°C recorded on 26.VI.2007 in Cujmir***[20] in Mehedinti county, recorded during the most intense heat wave of June, throughout the history of meteorological observations, equal to the thermal maximum. absolute of June for the entire country registered in Oraviţa on 29.VI.1938 and 29.VI.2000. It is observed the increase of the frequency of intense heat waves compared to the nineteenth and twentieth centuries as well as exceeding the absolute monthly thermal maximums. Especially after 1990 in June, the number of dog days increased. The highest maximum temperature values were registered after 2000, and lower thermal minimums were registered, before 1900 and some in the first half of the 20th century, which confirms the climate warming in June. The few exceptions are due to the discontinuity of the data strings. The old absolute maximum of June in Oltenia was 39.5°C recorded in 1908 in Calafat, unclassified for almost a century. The year 2007 was the first year in which the air temperature in June in Oltenia reached and exceeded 40°C, and exceeding the absolute monthly maximum was 2.5°C. ***The absolute minimum thermal temperature of June***[21]***, in the low altitude area is 1.0°C recorded at Baia de Arama and Strehaia*** in 1899 and at Drăgăşani in 1942; in the sub-mountain area is 0.5°C recorded in Voineasa on 1.VI.1990, and in the mountain area -4.9°C in Parâng recorded in 1962. For Oltenia, June is the first month of the year in which the air temperature does not go down at 0°C.

[20] In the specialized literature it is shown that in the last century, in June, once the air temperature in Romania reached 42.0°C, that is to say, on 29.VI.1938 in Oraviţa it was registered, 42.0°C, which constitutes until today , the absolute maximum value of this month (Bogdan and Niculescu, 1999; Marinică, 2006, 2007).

[21] The absolute minimum air temperature in June in Romania is -2.7°C recorded on 13.V.1950 at Întorsura Buzăului. June is thus the last month of the year in which the air temperature in Romania can drop below 0°C.

3.8. Variability of the Earth-Sun geometry in July and its consequences on the climate in Oltenia.

On 1.VII the sun rises at 05.54`s and sets at 21.00h, ie the duration of the day is 15h and 28`; is equal to that of the last day of June. ***The maximum duration of the day in July is 15h28`*** and it is registered in just 1 day on 1.VII. ***The minimum duration of the day*** is 14h41` and is recorded only on the last day 31.VII. ***The day registers a decrease between 1 and 31.VII, of 47` (with the daily average of 1`31``)***, so ***in total in July the monthly decrease of the day is 47`.*** In July there are 4 ***days with a decrease of 0`, 7 days with a decrease of 1` and 20 days with a decrease of 2`*** (of which 14 days are consecutive in the range 18-31.VII). Around July 3-4, Earth is at aphelion, which is the largest distance from the Sun. As a result, during July, the Earth's thermal equator has the northernmost position, as does the polar climate front, which is positioned north of the Svalbard Archipelago. In the last decade of July, the Earth's thermal equator begins its southward migration as does the polar climate front. July is the peak summer month and the hottest month of the year, representative for the summer season. The sun reaches a maximum altitude of about 67° in summer, (respectively, almost 20° in winter). The amount of radiated energy received from the Sun per square meter is proportional to the sine of the altitude angle. So the ratio of solar energy received in the summer and winter at noon per square meter (in aphelion to perihelion) is 2.69, meaning that summer receives 2.69 times more energy than in winter.

The average monthly temperature ranges from 17.1°C in Voineasa to 23.2°C in Calafat. Higher values are recorded in the southern half of the region (22.0°C at Slatina, 22.3°C Craiova, 22.8°C at Băileşti, 22.9°C at Caracal, 23°C at Dr. Tr. Severin and Bechet and 23.2°C at Calafat). *The general average for the entire region is 20.5°C*, with a jump of 2.1°C, compared to June. *The average monthly temperature increases* in July compared to the first summer - June are modest and range from 1.5°C in Slatina to 3.9°C in the extreme south of the Oltenia Plain at Bechet. The increase of the general monthly average for the whole region is only 2.1°C, ***being the last increase of the average monthly temperature during the year and the second one in ascending order after the one between January and February.***

The absolute monthly maximum temperature of July in Oltenia as for the whole country is 44.3°C recorded on 24.VII.2007 in Calafat, during the strongest heat wave of July in the entire history of meteorological observations. It was observed that the monthly thermal maximums were exceeded at short intervals at the weather stations in Oltenia, starting with 1990 and the increase of the intensity of the heat waves. *The old absolute maximum temperature* for July for the whole country was 42.9°C recorded on 5.VII. 1916 in Alexandria, and in Oltenia 41.8°C at Strehaia recorded on the same date. These values remained unclassified until 5.VII.2000 (for 84 years) when the first large exceedance of these values occurred during the strong heat wave from 4-6.VII.2000. Then the thermal maximum was

registered for the whole country 43.5°C (on 5.VII.2000) in Giurgiu (exceeding 0.6°C the old maximum), and in Oltenia, at the same date there was 43.0°C in Bechet (exceeding, after 84 years, with 1.2°C the old absolute maximum of 1916).

The second major exceedance of the monthly maxima occurred during the most intense heat wave of July 24-26.VII.2007 when on 24.VII.2007, in Oltenia there were registered at three maximum thermal weather stations. ≥40.0°C (44.0°C in Băileşti, 44.2°C in Bechet and 44.3°C in Calafat), "moving" the absolute maximum thermal temperature of the month of July from Giurgiu county in the southwest of Dolj county and approaching it only 0.2°C of absolute thermal maximum for the whole country[22].

Droughts are directly related to the increase in temperature values and occur on large areas of the continent. No doubt, this continuous amplification of the heat waves in July as well as the increase of their intensity as well as of the extension area of the hot tropical air is directly related to the massive deforestation that took place after 1990, both in Romania and in the Balkan Peninsula and Europe changing the albedo of the Earth's surface, but also with increasing quantities of pollutants from the Earth's atmosphere. ***The absolute monthly minimum temperature of July*** in Oltenia is 3.5°C recorded on 23.VII.1971 at Apa Neagră and on 15.VII.1993 at Voineasa (a very close value is 3.6°C, recorded in 1903 at Baia de Brass), and in the mountain area 1.4°C in Parang.

The absolute temperature temperature in July for Oltenia is 40.8°C, being the lowest throughout the year.

3.9. Variability of the Earth-Sun geometry in August and its consequences on the climate in Oltenia.

On 1.VIII The sun rises at 6:06 am and sets at 8:20:50 pm, ie the day length is 2:38 pm; ***The maximum duration of the day is 14h 38` and is recorded on 1.VIII.*** The first day of the year with the decrease of the duration of the day 4 minutes is on 10.VIII, day in which the duration of the day is 14 hours and 15`. Only two days in August have the decrease of the day by 4 minutes, and the second day is on 16.VIII, that is the first day in which the day's duration falls below 14 hours (the duration of the day in 16.VIII is 13h59`), and the duration of the night easily reaches and exceeds 10 hours (10 hours and 1 minute) and ***from a meteorological point of view the nights begin to cool***. Daily temperature minima usually fall below 20°C, so the frequency of tropical nights decreases. ***The shortest day of the day in August*** is recorded on 31.VIII and is 1.17 pm. So in August for 15 days the day duration is ≥ 14h. So ***in total in August the monthly decrease is only 1h21`, with the daily average of 2`36``.*** On the 29th of August, the Sântionul de Toamnă is celebrated („The cutting of the head of St. Ion"), and according to the

[22] ***The absolute maximum temperature for Romania***, for all months of the year, is 44.5°C, recorded on 10.VIII.1951 in Râmnicelu commune, at the Ion Sion farm in Bărăganul Brăilei (Brăila county).

popular tradition "the cold of autumn begins", that is, the thermal regime specific to September is installed and the nights cool down. In August there are 11 days with decreases in the duration of 2 minutes, 18 days (of which 6 consecutive days between 20-25.VIII and another 5 in the interval 27-31.VIII.) With decreases in the duration of 3 minutes and 2 days with decreases of the duration of the day of 4 minutes (on the dates of 10 and 16.VIII). August is the last summer month, almost as warm as July, and in some years even warmer, although the monthly averages fall slightly from July. The average monthly temperature ranges from 16.3°C in Voineasa to 22.7°C in Calafat. The highest monthly averages are recorded in the southern half of Oltenia (22.2°C at Tr. Severin, Craiova and Slatina, 22.4°C at Caracal and Slatina and 22.7°C at Calafat). ***August is the first month of the warm season in which there is a decrease of the average monthly temperature compared to the previous month, at most weather stations, except for one - Slatina[23] in the Getic Piedmont, where the average grows very easily***. *The decreases of the average monthly temperature* in August compared to the peak month of summer - July are modest and range between -0.8°C at Dr. Tr. Severin and Voineasa and -0.1°C the central part of Oltenia in Craiova. The decrease of the general monthly average for the whole region is only -0.5°C, being ***the smallest decrease of the average monthly temperature throughout the year***. *The monthly average temperature for the whole region is 20.0°C. The absolute monthly maximum temperature of temperature in Oltenia is 43.5°C* recorded on 20.VIII.1946 in Strehaia in the county of Mehedinţi, which remains unclassified until today. *The absolute minimum temperature of temperature in August in Oltenia* is 1.0°C registered in Voineasa on 29.VIII.1981, and in the mountain area also registered -0.6°C in Parang, the only negative value in August in the mountain area. The temperature minima of August are usually recorded in the last peak of the month and can be considered due to the early installation of the specific thermal regime for the first month of autumn, September. *The absolute amplitude* of the temperature in August is 42.5°C, higher by 1.7°C compared to July. ***During the summer from 21.VI to 31.VIII the decrease of the duration of the day is 2h12`.***

3.10. Variability of Earth-Sun geometry in September and its consequences on the climate in Oltenia.

On 1.IX is the last day of the year when the Sun sets after 8 pm, ie at 8:01 pm. On 1.IX the sun rises at 6:47 am and sets at 8:20 am, ie the day length is 13:14; At 11.IX the sun rises at 6:59 pm and sets at 7:43 pm, ie the day length is 12:44 pm; is the last day of the year in which the Sun rises before 07:00, and at 12.IX the sun rises at 07:00. On 26.IX The sun rises at h07: 16` and sets at h19: 15`, ie the

[23] The Slatina weather station was officially established in 1977 (but discontinuous data strings have been around since 1893). The averages from Slatina being calculated on the basis of data from these 35 years with continuous rows, from the period when the climatic warming was accentuated, which explains the positive deviation of 0.2°C).

day's duration is 11h and 59`; is the first day of the year that lasts less than 12 hours. On 30.IX, the sun rises at 07:01 and sets at 19:08, which is 11:47; ***The day registers a decrease between 1.IX and 30.IX, of 1h27`, with a daily average of 2`54``. On 22.IX or 23.IX the Autumnal Equinox is produced*** (the day is equal to the night in the sense that the face of the Earth illuminated by the Sun is exactly the same as the shaded one). In five days, the duration of the day is reduced by 4 minutes (each decrease at 5 ... 6, 7 days); in 20 days of 3 minutes (of which 5 are consecutive in the range 18-22.IX) and in 4 days of 2 minutes.

September is the first calendar month of autumn, and in some years at least until 15.IX, it still retains many of the features of summer. In most years the weather is nice and warm. *September is the last month of the warm season, and the decrease of the average monthly temperature compared to August of -4.2°C is the first major decrease of the average monthly temperature during the year, which occurs immediately after the hot summer season*. The monthly average temperatures are between 12.3°C in Voineasa and 18.4°C at Dr. Tr. Severin and Calafat. The largest monthly averages are recorded in the southern and western half of the region where the warm influences from the south and southwest are felt (17.6°C Drăgăşani, 17.7°C at Craiova, Băileşti and Bechet, 17.8°C at Caracal, 17.9°C at Slatina 18.4°C at Dr. Tr. Severin and Calafat*). The general average for the whole Oltenia region is 15.8°C. The decreases of the average monthly temperature in September* compared to the last summer month - August, are significant and range between -4.8°C in Băilești in the Oltenia Plain and -3.8°C at Dr. Tr. Severin in the extreme west and Polovragi in the Sub-Carpathian Depression. In the mountain area the decrease is -3.3°C in Parang, lower than in the low altitude area, as an effect of the thermal inversion phenomenon. ***The absolute monthly thermal maximum in September is 43.5°C registered on 8.IX.1946, a value that is also the absolute maximum thermal temperature of September for the whole country. Thus Oltenia holds the absolute thermal record for three months of the year: April, July and September. The absolute minimum temperature of temperature in Oltenia*** is -4.7°C registered in Voineasa on 30.IX.1970, and in the mountain area -6.3°C in Parang on 29.IX.1970[24]. Low thermal minima were recorded in 1906 at: Tg. Jiu, -4.0°C; at Rm. Valcea and Călimăneşti, -3.5 ° C; at Slatina -3.1°C; at Caracal -3.0°C, at Corabia -1.2°C and at Drăgășani, -1.0°C. In the specialized literature it is shown that in September the thermal minimums fell below 0°C at most weather stations in Romania. In Oltenia, the exception is the Dr. Tr. Severin weather station with the minimum 0.0°C, registered in 1931, and here a single near value was recorded over time, namely 0.4°C on 30.IX.1977. *The absolute temperature amplitude in September* for the entire Oltenia region is 48.2°C, 5.7°C higher than in August.

[24] The absolute minimum thermal temperature in September, in the Romanian Carpathians is -15.0°C, recorded on 18.IX.1935 at Omu Peak.

3.11. Variability of the Earth-Sun geometry in October and its consequences on the climate in Oltenia.

On 4.X is the last day of the year in which the Sun sets after 7 pm (even at 19), after this date it will set before 7 pm. On 1.X the sun rises at 07:22 and sets at 19: 05` (+, - 1`) so the duration of the day is 11h43`. The date of 15.X is the last day of the year with duration ≥11 hours (11h02`), then the duration of the day falls below 11 hours. At 20.X the sun rises at 07:46 and sets at 18:32, so the duration of the day is 10:46. At 31.X the sun rises at 07:00 and sets at 17:15, so the duration of the day is 10:15. It is the last day of the year (31.X) in which the Sun rises before 07:00 (even at 07). After this date it will rise after 07. It follows that ***in October the decrease of the duration of the day is 1h28`***, that is equal to that of September. ***The average decrease in the duration of the day is 2`50"***, lower than the average daily decrease in September by 6". There are ***7 days with decreases of the duration of the day by 2`, 18 days with decreases of the duration of the day by 3` and 6 days with decreases of the duration of the day by 4`.***

The monthly average temperature for the whole region is 10.4°C, registering a drop of -5.9°C compared to September, being *the largest temperature drop from one month to another throughout the year, which creates the impression that the cold season it starts suddenly. Since 20.X, haze is considered a normal phenomenon. The monthly average temperatures* are between 7.2°C in Voineasa and 12.2°C at Dr. Tr. Severin. Values higher than 11.0°C are recorded in the southern half of the region: 11.2°C at Slatina and Băileşti, 11.3°C at Bechet, 11.4°C at Craiova, 11.5°C at Caracal, 11.7°C at Drăgăşani, 11.9°C at Calafat and 12.2°C at Dr. Tr. Severin. *The decreases of the average monthly temperature in October* compared to the first autumn-September month are significant and range from -6.7°C in Slatina in the Getic Piedmont to -5.1°C in Voineasa in the intramontal depression. In the mountain area the decrease is -4.0°C in Parang, lower than in the low altitude area, as an effect of the thermal inversion phenomenon. ***The absolute monthly maximum temperature in October is 37.5°C recorded on 3.X.1952 in the southeast of the region in Studina (Olt County)*** (43°57′26″ N, 24°24′52″ E), and in the mountain area 21.2°C at Parâng in 1943. Also at the same time (3.X.1952) in Oltenia there were also exceptional temperature values: 36.7°C at Cezieni, 35.2°C at Corabia, 35.0°C at Leu and Segarcea, 34.5°C in Băileşti, 34.0°C in Slatina Strihareţ, 33.6°C in Drăgăşani, 30.7°C in Aninoasa (Gorj county). In Oltenia the frequency of monthly maximum temperatures ≥30.0° C is between 8-24%. October is thus the last month of the year, after the hot season, in which the air temperature can exceed 37.0°C, and at the level of the whole country, with the frequency of 1/100 years it can approach 40.0°C[25]. Usually the monthly maximums are recorded in the first decade and most frequently in the first peak of the month.

[25] The absolute maximum thermal temperature of October in Romania is 39.0°C recorded on 3.X.1952 in Armasesti, Ialomita County.

The number of hot and excessively hot days in October is small, usually between 1-5 days. ***The absolute monthly minimum temperature in October is -11.4°C recorded on 11.X.2011 at the Apa Neagră***[26], and in the mountain area - 11.5°C at Parang on 25.X.1979, which confirms the tendency to overtake the thermal extremes in both directions for this month. Monthly thermal minimums are usually recorded in the last decade of the month and even in the last peak. T*he absolute monthly air temperature amplitude for the entire Oltenia region*, in October, is 48.9°C, 0.7°C higher than in September.

3.12. Variability of the Earth-Sun geometry in November and its consequences on the climate in Oltenia.

The date of 1.XI is the first day of the year when the Sun rises after 7:00. Starting with the date of 3.XI, there are decreases in the duration of the 2 minute day, so the "speed" (rhythm) of the day decreases. After this date there are no more 4-minute decreases (due to the approach of the winter solstice). 8.XI is the last day of the year when the duration of the day is ≥10 hours (even 10 hours). The date of 8.XI is the last day of the year when there is a decrease of the day by 4 minutes. The date of 13.XI is the last day of the year when the Sun sets after 5 pm (even at 5 pm). After this date it will arrive before 5 pm. It follows that in November the ***decrease of the duration of the day is 1h04`.*** In November, the decrease of the day's duration slows down, registering only a day with a decrease of 4 minutes (7.XII). After 20.XI, the decrease becomes even slower with values of 1-2 minutes from one day to another (a single day also decreases by 3 minutes in 23.XI) as a result the weather variability becomes less intense and the models of forecasts give more stable results over time. *The average decrease in daytime duration is 2`8",* being the smallest daily average decrease in daytime duration in the fall. As a result, *the decrease of the duration of the day during the caledarist autumn (1.IX - 30.XI) is 4 hours*, and this *decrease corresponds to a decrease of the average temperature in Oltenia of 15.6°C, during the fall season, that is, an average decrease monthly 5.2°C.* The monthly average temperatures range between 2.2°C in Voineasa and 6.4°C at Dr. Tr. Severin. With the decrease of the day's duration below 10 hours, cold days become more frequent. In November, *the monthly average temperature drop (for Oltenia)* from October to November is Δt = -5.5°C (*average November temperature decrease*); *The absolute maximum thermal for Oltenia is 27.9°C registered in Bechet (Dolj county) on 10.XI.2010; The absolute minimum thermal for Oltenia is -21.2°C registered at Apa Neagră (Gorj county) on*

27.XI.1993; The absolute monthly air temperature amplitude for the entire Oltenia region, in November, is 49.2°C, 0.3°C higher than in October.

[26] The absolute minimum temperature of temperature in Romania in October is -21.3°C registered on 27.X.1988 at Întorsura Buzăului. October is thus the first calendar month of the year, after the hot season, in which the minimum temperature can drop below -20.0°C.

4. CONCLUSIONS

The variability of the Earth - Sun geometry for the latitude of Oltenia (and not only) is extremely high and correlates with exceptionally high climatic variability. This variability is determined by the movement of the Earth on its trajectory around the Sun. The precession motion of the axis of rotation of the Earth associated with the movement along the trajectory of the Earth, determines the succession of seasons. For the latitude of the central part of Oltenia, ***the maximum difference between night and day duration during the winter solstice is 378 minutes (6 hours and 18 minutes) and records in five days: 19, 21, 22, 23 and 25.XII. The maximum difference between the duration of the day and the duration of the night during the summer solstice period is 424 minutes (7 hours and four minutes) and is recorded in three days: 19, 20 and 24.VI, exceeding by 46 minutes the maximum difference between the duration nights and days during the winter season. This inequality of the two differences shows a significant asymmetry in favor of the summer season compared to the winter season*** (Fig. 3). These astronomical features analyzed above show that no matter how great the global climate warming, the succession of seasons will never disappear.

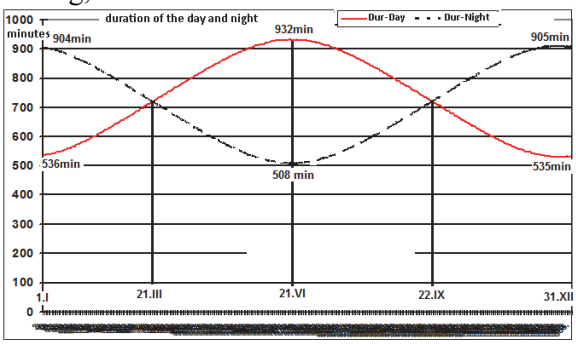

Fig. 3. *Variation of day and night duration during one year (in minutes) at the weather station of Craiova (Dur-Day = day duration, Dur-night = night duration). (source: processed data).*

The astronomical characteristics of the Earth's motion along its trajectory are the main causes that determine: the variation of the amount of heat received from the Sun within wide limits, the migration of the Earth's thermal equator over enormous distances from the positioning in southern Africa (south of the 40° S parallel) in January until the position near the latitude of 50° N in July. The polar climate front in the northern hemisphere migrates from northern latitudes in summer (north of 70° N) to southern latitudes of nearly 30° N in winter in the northern hemisphere. The summer of the northern hemisphere is warmer by 1.6°C on average than that of the southern hemisphere due to the large stretches of land that is warmer than the large stretches of water in the southern hemisphere. Corresponding to these very large variations of the climatic processes in the

northern hemisphere, in Oltenia the climatic variations are very high from the minimum of negative temperature in winter of -35.5°C in Craiova (15.I.1963) - 33.8°C (Strehaia 25 .I.1938) etc. at absolute maximum values very high in summer 44.3°C on 24.VII.2007. Which determines the maximum thermal amplitude of 79.8°C. For Oltenia, there is also a strong asymmetry (of 8.8°C) between absolute thermal maximums and absolute thermal minimums in favor of absolute maximum values (valid for large areas of the Earth). Corresponding to these large variations, the main rainfall is recorded in the spring and in the first part of the summer and the maximum rainfall in the fall. The dry period of the year with aridization phenomena, especially in the south of Oltenia, corresponds to July and August. The summer is often extended during the months of September and autumn, in some years until December 25, causing the seasons to be translated. Over these large climatic variations, which correlate perfectly with the variations of the Earth-Sun geometry, the variations determined by global climate warming overlap. The alternation of the polar day with the polar night, consequence of the precession movement of the axis of the Earth and the movement of the Earth on its trajectory, determines the greatest and strongest climatic oscillation - the succession of the seasons (except the intertropical zone). This climatic oscillation is subordinated to all major climatic processes and all plant and biotope processes.

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