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Variability of Atmospheric Cloudiness and Sunshine Duration in the Câmpulung Muscel Depression (Argeș – România)

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ABSTRACT

Atmospheric cloudiness and sunshine duration are the most important climatic parameters in assessing the radiative potential of a certain region which influences ecosystems, particularly, plants grow and developement. Cloudiness represents the totality of the clouds of the sky, or, in an exact sense, the degree of sky coverage with clouds, expressed in tenths of overcast covered sky. The degree of sky coverage and the clouds types are dependent on the evolution of air masses, on the afferent atmospheric fronts and underlying surface features. The sunshine duration represents the time interval corresponding to the presence of the solar disk on the sky and it is expressed in hours and tenths of hour. The two parameters are in an inverse relationship, the high cloudiness causes a low sunshine. In this paper, there was analysed annual, seasonal, monthly cloudiness and sunshine duration variation, in the Câmpulung Depression, in the 1961-2010 period, 1971-2010- period respectively. In this region, the cloudiness regime records a maximum in April and a minimum in August, while the sunshine duration has a minimum in December and a maximum in July.

KEYWORDS: Cloudiness frequency, Lower cloudiness, Total cloudiness, Percentage of possible sunshine, Sunshine duration.

INTRODUCTION

Cloudiness is the meteorological element that influences the climate system, acting directly on the solar radiation, terrestrial radiation and rainfall (Quante, 2004; Warren and Eastman, 2007). In recent decades, many researchers have been studying the cloudiness and types of clouds: for Europe and the Soviet Union, Henderson-Sellers (1986), Maugeri et al. (2001), Sun and Groisman (2000), in North America and the United States, Dai et al. (2006), Henderson-Sellers (1989) and Milewska (2004), Sun and Mokhov (2001), Sun (2003), Sun and Groisman (2004), in Australia, Jones and Henderson-Sellers (1992), in China, Kaiser (1998; 2000), Li et al. (2011).

Cloudiness is the main regulator of the sunshine duration, influencing the energy balance (Sanchez-Lorenzo et al., 2012). The presence of clouds can cause a warming effect by the absorption of the long wavelength radiation or a cooling effect, through short wavelength radiation reflection back into space. Thus, the overall effect of the Stratus clouds types, slightly transparent to solar radiation (the cloud with high albedo) and at a temperature close to that of the soil surface , acts for the cooling the Earth-Atmosphere system (Mace et al., 2006), while the Cirrus clouds, thin, cold, and transparent to the short wavelength radiation (the cloud with low albedo) leads to a heating of the system (Lynch, 1996).

Studies about sunshine duration were realised by: Angell (1990), Brázdil et al. (1994), Curto et al. (2009), Pallé and Butler (2002), Sanchez-Lorenzo et al. (2008), Xia (2010).

MATERIAL AND METHODS

The Câmpulung Depression is located in the northeastern part of the Argeș County, at the foothills of the Iezer Mountains, on the Târgului River, between the valleys of Bratiei on the West, and the Dâmboviţa River on the East. Relief consists in the river valleys that run through the hills in the form of rolling hills, resulting in a typical aspect of depression which is relatively elongated in shape, resembling a "long field" (Geografia României, 1992).

Dependent on the frequency and degree of development of the baric systems wich act in the analized region and the intensity of the local thermoconvective processes, cloudiness and sunshine duration vary from one year to other, from one season to other, from one month to other.

In this study there were used daily dates on the cloud cover, for the period 1961-2010 and sunshine

duration, for the period 1971-2010, from the archive of Câmpulung meteorological station.

Series of data were processed in MS Excel. For total and inferior cloudiness were calculated and interpreted: monthly and annual variation, the four periods of observation variation, their frequency and annual and seasonal frequency of clouds types. For sunshine duration were calculated and interpreted: annual, seasonal, monthly and daily variation, monthly and annual frequency of days with sunshine and percentage of possible sunshine.

RESULTS AND DISCUSSIONS

Atmospheric cloudiness

In specialized practice, it differentiates a total cloudiness, when assessments are made globally on all clouds types and a lower cloudiness when assessments are made to the quantity of clouds whose base is located in the lower floor, below an altitude of 2000 m, generally: Nimbostratus, Stratocumulus, Stratus, Cumulus and Cumulonimbus.

In the Câmpulung Depression, total cloudiness varies more from one year to other, from one month to other, being influenced by the various baric systems, crossing or stationed over this region. Thus, between 1961-2010, total cloudiness were ranged between 4.9 tenths and 6.7 tenths, multiannual mean being 5.9 tenths (fig. 1).

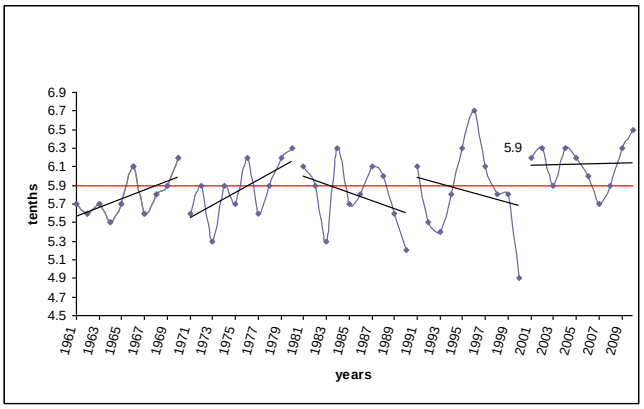

Fig.1 Annual variation of total cloudiness (tenths) , in the Câmpulung Depression (1961-2010)

The lowest values of total cloudiness were recorded in years: 2000 (4.9 tenths), 1990 (5.2 tenths), 1973 and 1983 (with 5.3 tenths), 1993 (5.4 tenths) and 1964 (5.5 tenths). Years with the highest total cloudiness was: 1996 (6.0 tenths), 2010 (6.0 tenths), 1980, 1984, 1995, 2002, 2004 and 2009 (with 6.3 tenths) and 1970, 1976, 1979, 2001 and 2005 (with 6.2 tenths).

In the first two decades, total cloudiness presents upward trends, but in 1981-1990 and 1991-2000 decades it presents the downward trends. In the decade 2001- 2010, the mean cloudiness lies over a multiannual mean (6.1 tenths), with a slightly upward trend.

In the Câmpulung Depression, monthly means of total cloudiness highlights a principal maximum in April (6.7 tenths) and a principal minimum in August (4.8 tenths). Being a submountain region, in the annual evolution of total cloudiness records a secondary maximum of 6.3 tenths in December (fig. 2)

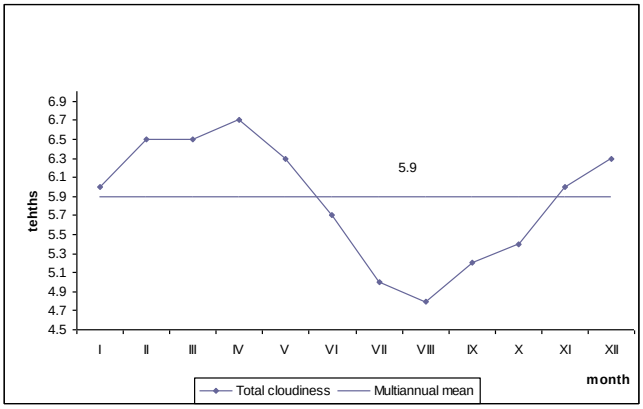

Fig.2. Monthly mean of total cloudiness (tenths) , in the Câmpulung Depression (1961-2010)

Diurnal evolution of total cloudiness highlights throughout the year, a maximum at 13^{00} hours and a minimum at 1^{00}, the annual mean being 6.8 tenths, in the first case and 4.9 tenths respectively, in the second one. For note is the fact that, during the night and in the early hours of the morning, maximum cloudiness is recorded in the months of February and March, this being of 5.8 tenths, at 1^{00} and 6.6 tenths at 7^{00} and lowest in July and August, 3.6 tenths at 1^{00} and 4.2 tenths at $7^{00.}$ At noon and in the evening, the maximum records in the months of April and May, and the minimum in October. Thus, at 13^{00}, the maximum was 7.7 tenths and the minimum of 6.1 tenths and at 19^{00}, the maximum was 7.1 tenths and the minimum was 5.3 tenths. (fig. 3).

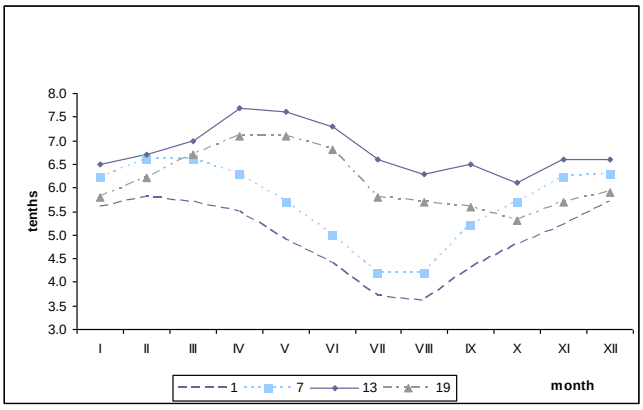

Fig.3. Monthly mean of total cloudiness (tenths) , at four terms of observation, in the Câmpulung Depression (1961-2010)

Lower cloudiness represents the degree of sky cloud coverage (in tenths) with clouds whose base is located in the lower stage, below an altitude of 2000 m: Nimbostratus, Stratocumulus, Stratus, Cumulus and Cumulonimbus types.

In the Câmpulung Depression, annual mean lower cloudiness during the 1961-2010, was 3.7 tenths, with limits of variation between 2.3 tenths and 4.7 tenths (fig. 4).

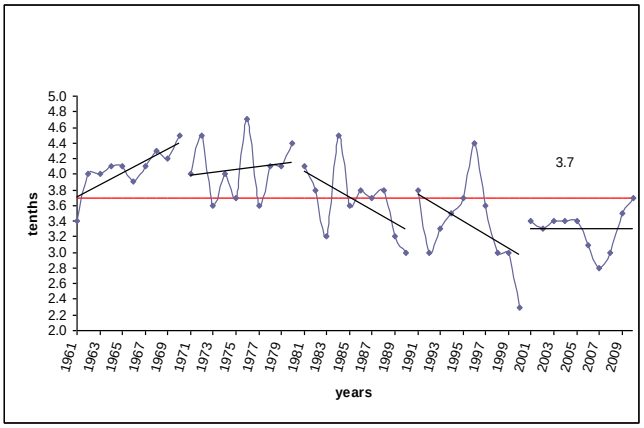

Fig.4 Annual variation of lower cloudiness (tenths), in the Câmpulung Depression (1961-2010).

Comparing the annual mean values of lower cloudines on the decades, there were observed that this decrease from 4.1 tenths in the first two decades, at 3.3 tenths over the last decade. Years with the lowest values of mean lower cloudiness were: 2000 (2.3 tenths), 2007 (2.8 tenths), 1990, 1992, 1998, 1999 and 2008 (with 3.0 tenths), 2006 (3.1 tenths), 1983 and 1989 (with 3.2 tenths), 1993 and 2002 (with 3.3 tenths) and 1961, 2001, 2003, 2004 and 2005 (with 3.4 tenths).

The highest annual values of the lower cloudiness were recorded in years: 1976 (4.7 tenths), 1970, 1972 and 1984 (with 4.5 tenths), 1980 and 1996 (with 4.0 tenths), 1967 (4.3 tenths), 1969 (4.2 tenths), 1964, 1965, 1967, 1978, 1979 and 1981 (with 4.1 tenths) and the 1962, 1963, 1971 and 1974 (with 4.0 tenths).

Monthly mean of lower cloudiness shows a maximum in April (4.1 tenths), after which it drops to 3.2 tenths in September-October, when recording the minimum (fig. 5). In February and December, there is a secondary maximum, whose value is 4.0 tenths.

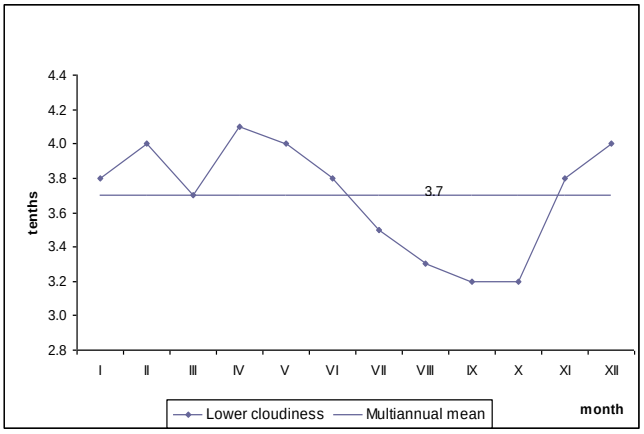

Fig.5. Monthly mean of lower cloudiness (tenths) , in the Câmpulung Depression (1961-2010)

Daily evolution of the lower cloudiness, at four terms of observations, presents an allure similar to that of the total cloudiness, with a maximum at 13^{00}, and a minimum at 1^{00}, except that in the hot season, the differences between the cloudiness values at noon and the other terms are much higher. Thus, during the winter months, cloudiness values at four terms of observations, are ranged between 3.5 tenths and 3.8 tenths, the mean differences being 0.1- 0.3 tenths. In June, the differences between the cloudiness values at 13^{00} and the other moments are ranged between 1.6 tenths at 19^{00} and 3.8 tenths, at 7^{00} (fig. 6).

During the night and morning, maximum cloudiness was recorded in December to February (3.6-3.7 tenths), and the lowest in July and August respectively (2.0 tenths). At noon and in the evening, the minimum cloudiness is recorded in the cold season, and the maximum in the hot season. Thus, at 13^{00}, minimum lower cloudiness was ranged between 3.7 tenths in January and 3.9 tenths, in November and February, and the maximum between 4.9 tenths in September and 6.1 tenths in June. At 19^{00} hours, minimum cloudiness was recorded in October (3.0 tenths) and the maximum in May and June (4.5 tenths).

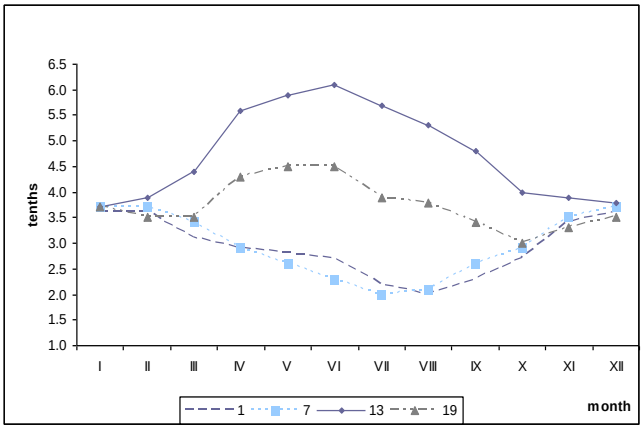

Fig.6. Monthly mean of lower cloudiness (tenths) , at four terms of observation, in the Câmpulung Depression (1961-2010)

The degree of sky cloud coverage varies from day to other, depending on local conditions and atmospheric circulation and as complete as possible characterization of this item it is necessary to analyze the frequency (the number of clear sky days and over covered both the total cloud cloudiness, as well as the lower cloudinees). Clear sky days are considered to be those which the sum of cloudiness, at the four terms of observations, is between 0 and 7 tenths, cloudy ones between 8 and 32 tenths, and those ones covered between 35 and 40 tenths (Clima Romaniei, 2008).

In the Câmpulung Depression, after total cloudiness, the annual mean number of clear sky days is 45.9 days. The highest number of clear sky days was recorded in 2000 (80 days), and the lowest in 1995 (25 days). The annual number of covered days was between 70 days in 2000 and 159 days in 1996, the multiannual mean being 107.4 days.

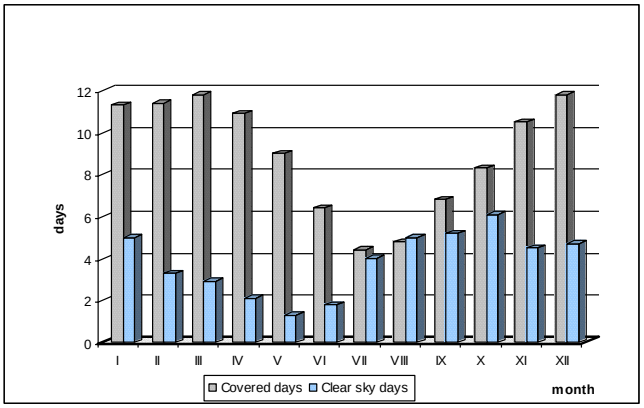

Fig.7. Monthly mean number of clear sky and covered days, after total cloudiness, in the Câmpulung Depression (1961-2010)

During the year, the highest number of clear sky days was recorded in the October (6 days), and the lowest in May (1.3 days). The highest number of covered days was registered in March and December (11.8 days), and the lowest number of days (4 days) in July (fig. 7).

In this area, cloudy days have the highest frequecy, this being ranged 46,7% in December, between and 72.9% in July and August (fig.8). On the characteristic months their frequency is as follows:

- January: 16.1 % clear sky days, 47.5 % cloudy days and 36.4 % covered days;
- April: 7.0 % clear sky days, 56.7 % cloudy days and 36.3 % covered days;
- July: 12.9 % clear sky days, 72.9 % cloudy days and 14.2 % covered days;
- October: 19.7 % clear sky days, 53.5 % cloudy days and 26.8 % covered days.

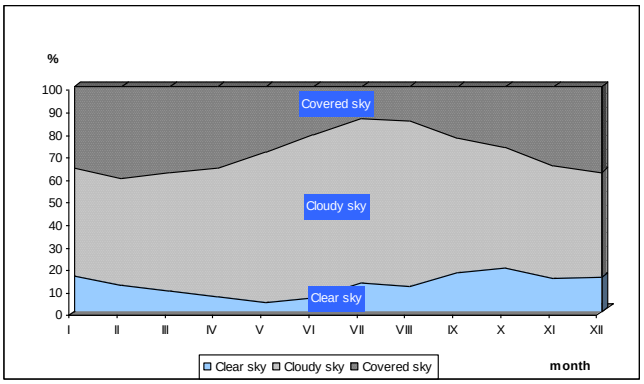

Fig.8 Frequency (%) of clear sky days, cloudy days and covered days after total cloudiness, in the Câmpulung Depression (1961-2010)

After lower cloudiness, the annual mean number of clear sky days is 127.6 days, with limits of variation ranging from 81 days in 1976 and 203 days in 2000, and that of the covered days was ranged between 18 days in 1992 and 74 days in 1976, multiannual mean being 45.1 days

During the year, the highest number of clear sky days is recorded in October (14 days), followed by January (13 days). The lowest number of clear sky days is recorded in June (6.0 days). The highest number of over covered days was in December (4 days) and January (6 days), when thermic inversions and stratiforms clouds have a high frequency, and the lowest in July (1.4 days) and (1.5 days), when prevails the anticyclonic regime and the weather is clear (fig. 9).

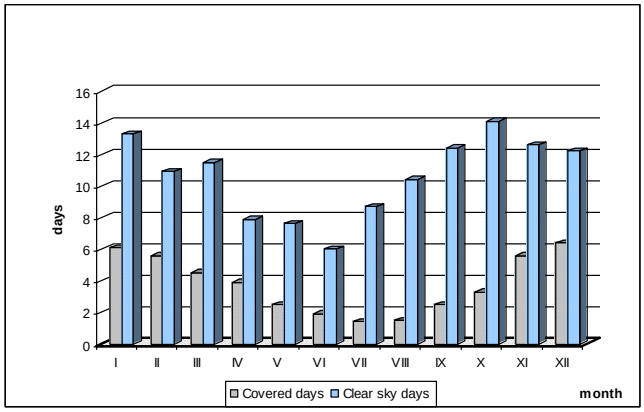

Fig.9. Monthly mean number of clear sky and covered days, after lower cloudiness, in the Câmpulung Depression (1961-2010)

The frequency of cloudy days, after lower cloudiness, is ranged between 37.4 %, in January and 73.7% in June (fig. 10). On the characteristic months their frequency is as follows:

- January: 42.1 % clear sky days, 37.4 % cloudy days and 19.7 % covered days;
- April: 26.3 % clear sky days, 60.7 % cloudy days and 13.0 % covered days;
- July: 20.0 % clear sky days, 73.7 % cloudy days and 6.3 % covered days;
- October: 45.5 % clear sky days, 43.9 % cloudy days and 10.6 % covered days.

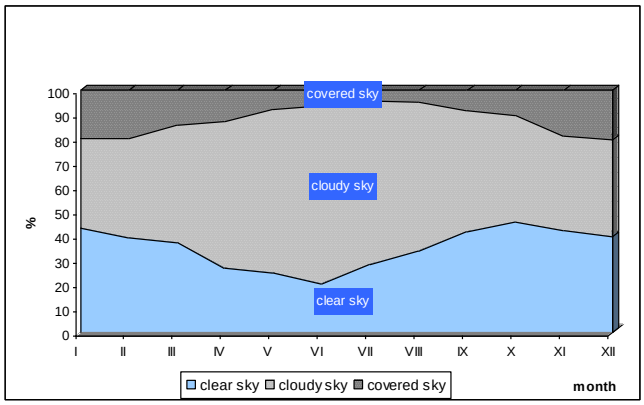

Fig.10 Frequency (%) of clear sky days, cloudy days and covered days after lower cloudiness, in the Câmpulung Depression (1961-2010)

Clouds represent a valuable indicator of thermodynamic processes, causing the appearance of weather aspect in the area over which there are by quantity, shape, height, or the evolution of their associations. Clouds are hidrometeors

formed from a suspension of tiny particles of liquid water or ice, or both at the same time, which generally do not reach the ground. They may also contain particles of water or ice for larger sizes, as well as liquid particles or solids from industrial smoke or dust.

The principal way for the cloud formation is adiabatic air cooling in an upward movement, the process by which water vapor content of air upward reach at saturation and the condensation occurs surplus water.

Clouds are classified by their aspect (cirrus, cumulus and stratus) after height: tall, based at 6,000 meters (Cirrus, Cirrostratus and Cirrocumulus), medium, located between 2000 and 6000 metres (Altocumulus, Altostratus, and Nimbostratus) and lower, below 2000 metres (Stratocumulus and Stratus) and convectiv cumulus type clouds (Cumulus and Cumulonimbus).

In the Câmpulung Depression, Cirrus clouds have a mean annual rate of 13.0% (fig. 11). In the cold season, their frequency is ranged between 10.4% in February and 13.1% in March (fig. 12). In the hot season, the highest frequency is recorded in May and June (16.7%), while the lowest is 12.2% in August (fig. 13).

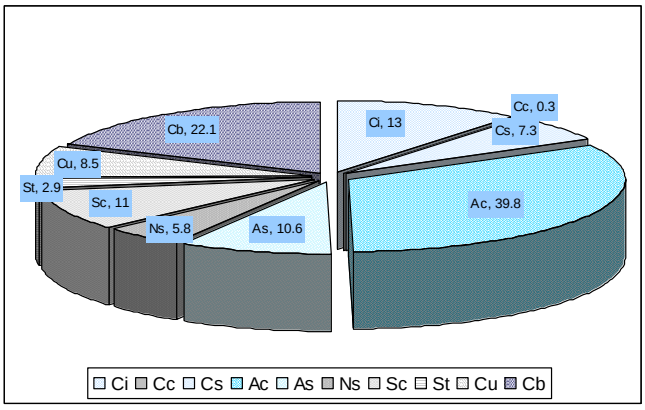

Fig.11 Annual mean frequency (%) of clouds types, in the Câmpulung Depression (1961-2010)

Cirrocumulus clouds have a low annual mean frequency (0.3%), higher frequency having in May, October and November (0.5%). The annual mean frequency of Cirrostratus clouds was 7.3%. During the year, the highest rate was recorded in April (11.2%), and lowest in July and August (4.1%). Altocumulus clouds have the highest annual frequency (39.8%). During the year, they are most frequently in March, April and May (42.9-44.6%).

Altostratus clouds are frontal clouds, with medium height, with a lower mean annual frequency (10.6%), the highest frequency being recorded at the end of winter and early spring (14.5% in February and 16.2% in March), and the lowest in July and August (4.4% and 4.3% respectively).

Nimbostratus clouds have a lower mean annual frequency (5.8%), the highest mean values being recorded in December to February (10.3-11.0%) and the lowest in July and August (0.7% and 1.0% respectively).

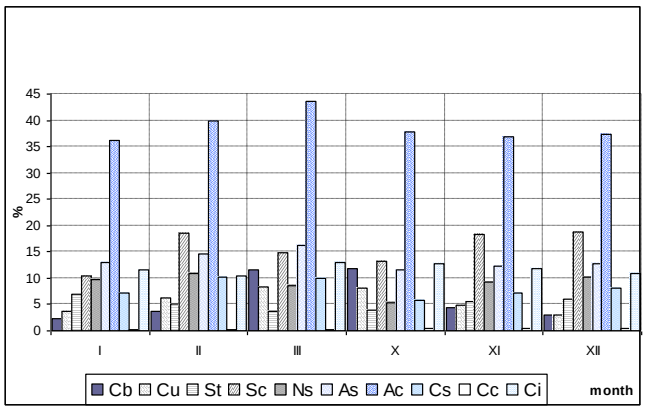

Fig.12. Monthly mean frequency (%) of clouds types, in the cold season, in the Câmpulung Depression (1961-2010)

Monthly mean frequency of Stratocumulus clouds in the Câmpulung region, is 11.0%, the highest values of this recorded in the cold season, during November, December and February months (18.3-18.8%), and lowest during June and July months (3.7-3.9%).

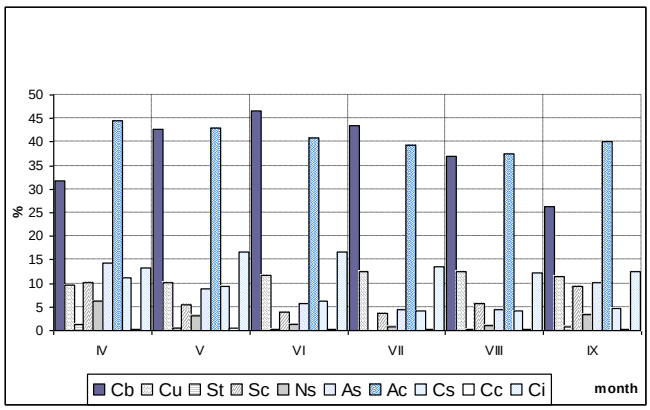

Fig.13. Monthly mean frequency (%) of clouds types, in the hot season, in the Câmpulung Depression (1961-2010)

Stratus clouds are frontal clouds and they characterize in particular the cold season of the year, the highest frequency having in December and January (6.1% and 6.9% respectively), and the lowest in May-August interval (0.1-0.4%), multiannual mean of these being 2.9%.

Cumulus clouds, being formed in principal by heat convection, based by vertical upward currents that develops in the unstable air masses, have a high frequency in the hot season (9.6% in April, 12.6% in August). The lowest monthly mean values are recorded in December and January (3.1% and 3.7% respectively), multiannual mean being 2.9%. Cumulonimbus clouds have the highest frequency in May-July (42.7- 46.7 %), and the lowest in December-February (2.3-3.8%).

Sunshine Duration

In the Câmpulung Depression, the sunshine duration varies much from one year to other. Heliographic records, in the period 1971-2010, highlights variations in sunshine duration

ranged between from 1800.9 hours and 2332.4 hours, multiannual mean being 2035.6 hours (fig. 14). The highest mean sunshine duration was recorded in the decade 1981-1990 (2091.3 hours) and the lowest in the decade 1971-1980 (1990.0 hours).

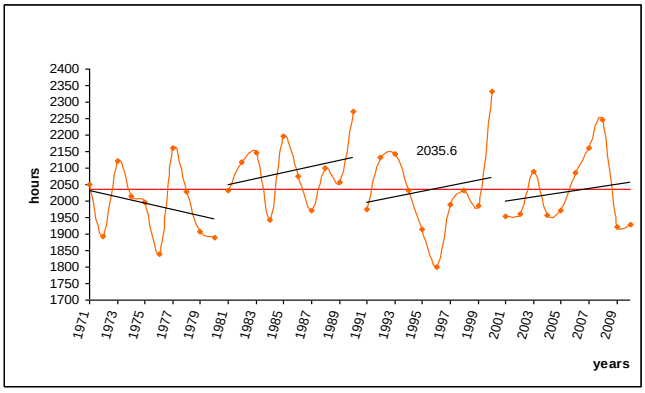

Fig.14 Annual sunshine duration (hours), in the Câmpulung Depression (1971-2010).

Low sunshine durations were recorded in years: 1996 (1800.9 hours), 1976 (1838.3 hours), 1980 (1888.0 hours), 1972 (1893.2 hours), 1979 (1908.5 hours), 1995 (1915.2 hours) and 2009 (1922.8 hours). The highest sunshine durations were in the years: 2000 (2332.4 hours), 1990 (2271.2 hours), 2008 (2247.3 hours), 1985 (2196.2 hours), 2007 (2161.9 hours) and 1977 (2161.2 hours).

In the cold season of the year (October to March), the sunshine duration was ranged between 445.8 hours in 2009 and 929.3 in 1989 (fig. 15). Multiannual mean sunshine duration, in this season, has a high value, this being 743.0 hours, with a share of 36.5% of annual insolation..For note is the fact that in the last 15 years of the study period, due to the high cloudiness frequency from this interval, the trend of sunstroke hours is downward.

Years with the lowest insolation hours, in winter, were: 2009 (445.8 hours), 1996 (540.7 hours), 1984 (615.0 hours) 2010 (616.2 hours), 1987 (629.8 hours) and 2001 (640.5 hours). High sunshine durations, in this season, were in years: 1989 (929.3 hours), 1990 (992.3 hours), 1973 (906.0 hours), 1983 (875.9 hours), 1977 (865.3 hours) and 2000 (855.1 hours).

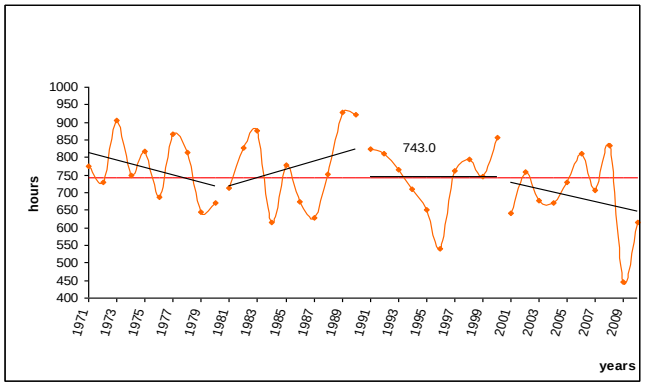

Fig.15. Sunshine duration (hours), in the cold season, in the Câmpulung Depression (1971-2010).

For the hot season (April-September) the share of the annual sunshine is 63.5%. In Câmpulung , in this period of the year, the sunshine duration was ranged between 1127.8 hours and 1477.3 hours, a multiannual mean in the season being 1292.6 hours (fig.16).

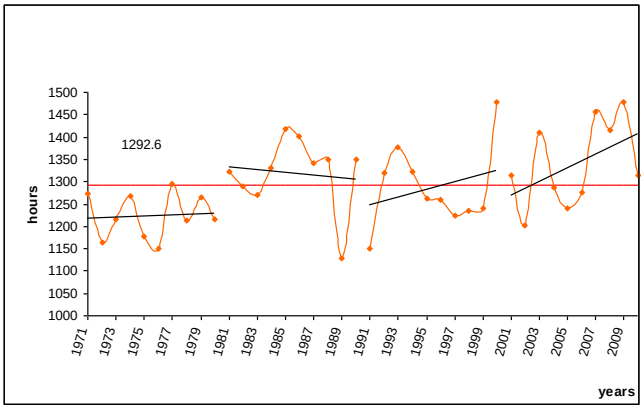

Fig. 16. Sunshine duration (hours), in the hot season, in the Câmpulung Depression (1971-2010).

For the past two decades, the trend of sunshine hours is upward. In the hot season, years with the lowest insolation hours were: 1989 (1127.8 hours), 1976 and 1991 (with 1151.1 hours), 1972 (1164.9 hours), 1975 (1178.8 hours) and 2002 (1201.4 hours).

The highest sunshine durations, in this season, were recorded in: 2000 (1477.3 hours), 2009 (1477.0 hours), 2007 (1457.0 hours), 1985 (1418.0 hours), 2008 (1414.1 hours), 2003 (1410.5) and 1986 (1402.0 hours).

During the year, the sunshine duration presents a high variability from one month to other, in correlation with the astronomical duration of the day and with the cloudiness regime.

In the Câmpulung Depression, the monthly minimum mean records in December (96.9 hours), a month in which the astronomical day is the shortest, and cloudiness has maximum values (fig. 17). The highest mean sunshine duration was recorded in July (259.0 hours).

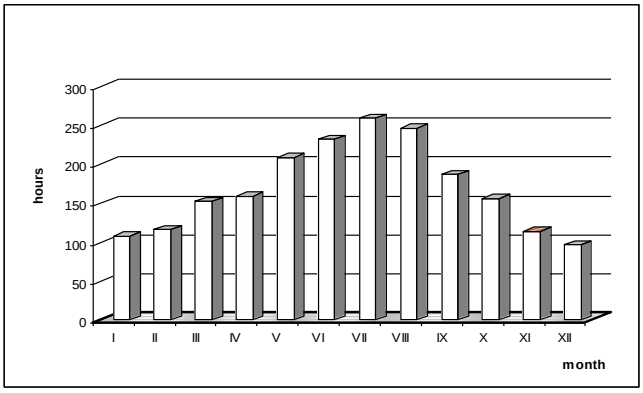

Fig. 17. The annual regime of the effective sunshine duration (hours), in the Câmpulung Depression (1971-2010).

In the Câmpulung Depression, daily mean sunshine duration varies between 4.4 hours in December and 8.6 hours in July,

it gradually increasing from the winter solstice and summer solstice, and then start to fall again (fig. 18).

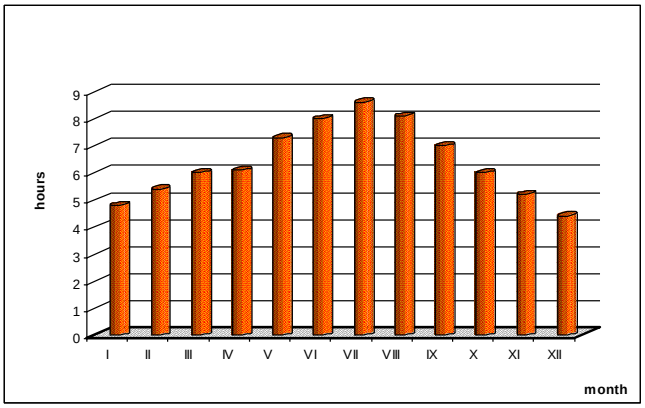

Fig. 18. Daily mean sunshine duration (hours), in the Câmpulung Depression (1971-2010).

The analysis of the daily sunshine duration evolution, by comparison, in 1996, during which recorded the lowest insolation hours (1800.9 hours) and 2000, with the highest number of insolation hours (2332.4 hours), the difference being 531.5 hours, highlights a high number of days without Sun in the first case. Thus, if in 1996, the number of days without Sun reaches 82 days, in 2000, these totalise 29 days, the most recorded in December - March interval (fig. 19).

With the exception of April, throughout 1996, the daily sunshine duration summarized monthly are lower with 8.8 hours to 84.0 hours during the cold season and lower with 7.9 hours to 68.0 hours in the hot season, compared to the year 2000.

In 1996, the maximum sunshine duration in the cold season, was ranged between 7.3 hours (January,16) and 9.5 hours (March,18), and in the hot season was between 9.4 hours (September,16) and 14.0 hours (July,14). In 2000, the maximum sunshine duration, in the cold season varied between 7.4 hours (December,2-3) and 10.1 hours (March,6), while in the hot season it was ranged between 11.3 hours (September,9) and 14.6 hours (June, 12, 28).

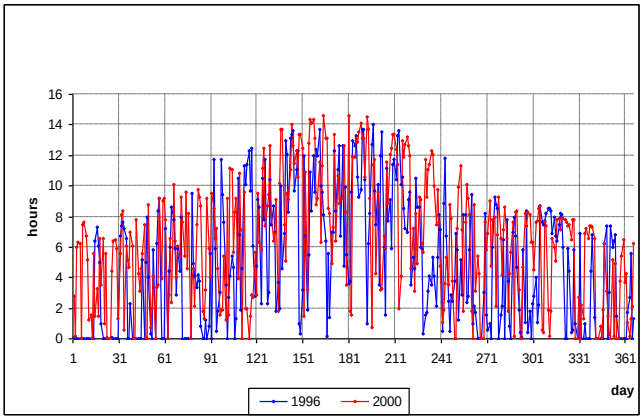

Fig. 19.Daily sunshine duration evolution (hours), in the Câmpulung Depression, in years 1996 and 2000.

Monthly mean number of sunny days has a minimum value in December (21.8 days) and it gradually increases until summer (30.3 days during July and August), after which it begins to fall, while the days without Sun are between 0.7-0.8 days during summer and 5.9-9.2 days in winter (fig. 20).

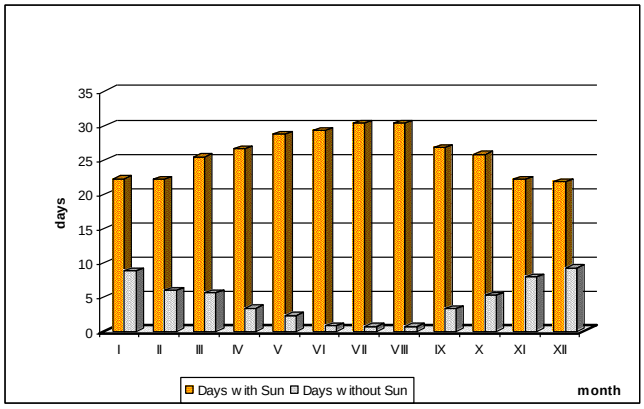

Fig. 20. Monthly mean number of days with and without Sun, in the Câmpulung Depression (1971-2010).

The annual mean number of days with Sun is 310.0 and the one without Sun is 55.2 (fig. 21). The most days with Sun were recorded in years 1989 and 2000: (with 337 days), 1992 (335 days), 1990 (329 days), 1983 (328 days), 1973 (324 days), 1975 and 2006 (with 321 days). Years with the lowest sunny days were: 1996 (284 days), 2010 (291 days), 2009 (294 days), 1972 and 1976 (with 295 days), 1995 (296 days), 2004 (297 days) and 1984 (299 days).

The percentage of possible sunshine constitutes one of the characteristics of the sunshine duration, which allows an assessment of measure which the cloudiness disrupts and it is defined as the percentage ratio of the effective sunshine duration (real time) and possible duration (astronomical duration) , which corresponds to the time between the sunrise and the sunset.

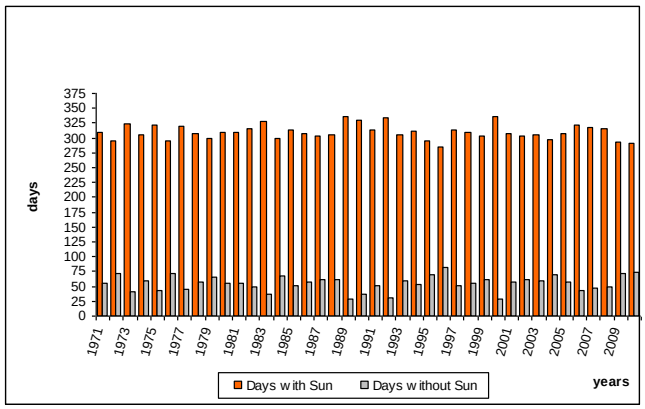

Fig. 21. Annual mean number of days with and without Sun, in the Câmpulung Depression (1971-2010).

In the Câmpulung Depression, the maximum monthly value of the percentage of possible sunshine records in August (56.5%), while the minimum in December (35,8%), multiannual mean being 44.8% (fig. 22).

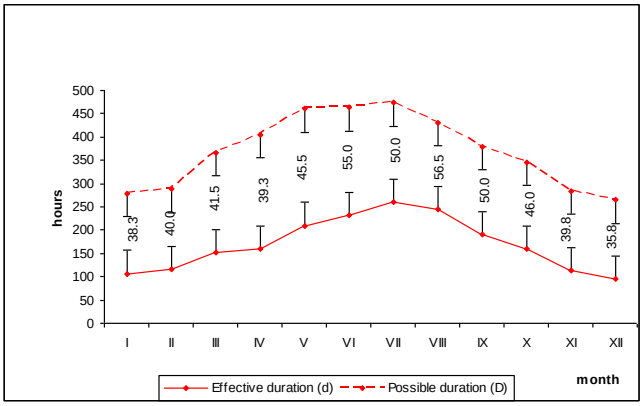

Fig. 22. Annual variation of percentage of possible sunshine (%), in the Câmpulung Depression (1971-2010).

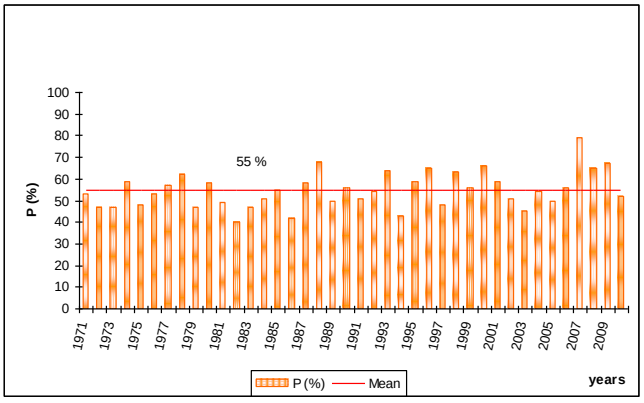

Fig. 23. Percentage of possible sunshine (%), in July, in the Câmpulung Depression (1971-2010).

In July, the multiannual mean of the percentage of possible sunshine was 55 % (fig. 23). The lowest values were recorded in years: 1982 (40%), 1986 (42%), 1994 (43%), 2003 (45%), 1972, 1973, 1979 and 1983 (with 47%), 1975 and 1997 (with 48%) and 1981 (49%), the 1989 and 2005 (50%).

Years with the highest values of percentage of possible sunshine were: 2007 (79 %), 1988 (68 %), 2009 (67 %), 2000 (66 %), 1996 și 2008 (65 %), 1993 (64 %), 1998 (63 %), 1978 (62 %), 1974, 1995 and 2001 (59 %), 1980 and 1987 (58 %).

CONCLUSIONS

In the Câmpulung Depression, multiannual mean of total cloudiness for the period 1961-2010, was 5.9 tenths, 1961-1990 –standard climatological period being 5.8 tenths.

Monthly means of total cloudiness highlights a principal maximum in April (6.7 tenths) and a principal minimum in August (4.8 tenths).

Diurnal evolution of total cloudiness highlights throughout the year, a maximum at 13^{00} hours and a minimum at 1^{00}, the annual mean being 6.8 tenths, in the first case and 4.9 tenths respectively, in the second one.

Annual mean lower cloudiness during the 1961-2010, was 3.7 tenths, with limits of variation between 2.3 tenths and 4.7 tenths.

Monthly mean of lower cloudiness shows a maximum in April (4.1 tenths), and a minimum in September-October (3.2 tenths).

Daily evolution of the lower cloudiness, at four terms of observations, presents an similar allure to that of the total cloudiness, with a maximum at 13^{00}, and a minimum at 1^{00}, except that in the hot season, the differences between the cloudiness values at noon and the other terms are much higher.

After total cloudiness, the annual mean number of clear sky days is 45.9 days. The highest number of clear sky days was recorded in 2000 (80 days), and the lowest in 1995 (25 days). The annual number of covered days was between 70 days in 2000 and 159 days in 1996, the multiannual mean being 107.4 days.

During the year, the highest number of clear sky days was recorded in the October (6.1 days), and the lowest in May (1.3 days). The highest number of covered days was recorded in March and December (11.8 days), and the lowest number of days in July (4.4 days). Cloudy days have the highest frequency, these being ranged between 46.7% in December and 72.9%, in July and August.

In this area, clouds types with the highest frequency are Altocumulus (39.8%), Cumulonimbus (22.1%) and Cirrus (13.0%), and those with the lowest frequency are Cirrocumulus (0.3%), Stratus (2.9%) and Nimbostratus (5.8%). In the cold season, Altocumulus clouds have the highest frequency the frequency (36.1- 43.5%), follow then Stratocumulus (10.4-18.8%). In the hot season, the prevailing clouds types are Altocumulus (37.6-44.6%) and Cumulonimbus (26.3-46.7%).

In the Câmpulung Depression, annual mean sunshine duration, calculated on the last four decades, was 2035.6 hours. The lowest insolation hours were recorded in 1996 (1800.9 hours) and the highest in 2000 (2332.4 hours).

In the cold season of the year (October - March), insolation has a 36.5 % share of annual value (743.8 hours), the main share (63.5%) returning to the hot season (April - September), the multiannual average being 1292.6 hours. During the year, sunshine duration presents a high variability from one month to other, in correlation with the astronomical day duration and with the cloudiness regime.. Monthly minimum mean records in December (96.9 hours) and maximum mean in July (259.0 hours).

The daily mean sunshine duration varies between 4.4 hours in December and 8.6 hours in July, it gradually increasing from the winter solstice and summer solstice, then start again to drop. The mean number of sunny days has minimum value in December (21.8 days) and it gradually increases until summer (30.3 days during July and August), after which it begins to fall, the annual mean number being 310.0 days. The monthly maximum value of percentage of possible sunshine records in August (56.5%),

and the minimum value in December (35.8%), multiannual mean being 44.8%

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