THE FREQUENCY OF LIGHTNING STRIKES IN THE WESTERN PART OF ROMANIA AND THEIR IMPACT IN THE TIMESCALE 1991-2020

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Abstract *The purpose of the present study is to present a climatology of stormy phenomena in the western part of Romania for the period 1991-2020. The climatological norm chosen is significant for current research due to the fact that the data available after 2010 are of high accuracy and can be integrated in other specialized studies in the fields of agriculture, civil engineering, energy and construction. In the study, observational data from the integrated meteorological system of aviation, satellite data and RADAR parameters were used to characterize the convective formations that produce these stormy phenomena. The choice of the western area of Romania is significant because the predominant zonal circulation brings moisture and conditioned unstable air into the researched area. It is also worth noting that stations from different orographic areas in the western part of Romania were chosen precisely to allow the performance of conclusive statistics for the entire research area. In this studio, the aero-synoptic situations that can trigger stormy phenomena were also taken into account outside of the late spring and summer season, a period specific to the manifestations of atmospheric instability. It was concluded that the transitional seasons present a high frequency of electrical discharges, and during the summer an increase in the duration of electrical discharges is noted.*

Keywords*: thunderstorms, lightning strikes, climatology, frequency, western Romania*

INTRODUCTION

In the climatic conditions of Romania, thunderstorms appear as a more special phenomenon, which can annually bring great damage to the national economy. For this reason, the knowledge of their development during the year is of interest for many activities and first of all for the design in many fields (energy, constructions, etc.) or the safe development of outdoor activities, by taking into account the annual intervals with the most electric discharges, for different regions in Romania, in order to design some works from the 1991 – 2020 period (ENACHE, 2012; SANDU ET AL., 2010).

Stormy phenomena are the result of processes specific to the development of Cumulonimbus clouds, under the conditions of an unstable stratification of the air, when there is a large amount of water vapour (COZMA ET AL., 2020). Thunderstorms occur in the case of intense convective air movements (thermal or dynamic, frontal or orographic) generated by the strong heating of air masses, their movements, the particularities of the relief and, in general, of the underlying surface (AUSTIN, 1980).

MATERIAL AND METHODS

For the preparation of the paper, the data from the observations made between 1991-1920 at 7 meteorological stations located in different regions of Romania, with various forms of relief and local conditions, were used.

The day when at least one lightning accompanied by thunder was heard audio-visually in the area where the station is located, the dates of their production being grouped by monthly

decades, was considered a "thunderstorm day". In this way, the decadal percentage frequencies of thunderstorm occurrence dates could be calculated (BÂZÂC, 1980).

Stormy phenomena are characterized by the great variability of production data during the year, even on uniform territories from a physical-geographical point of view. This is explained by the fact that in a certain region, although not very extensive in area, thunderstorms do not always occur on the same day. In some cases, the same meteorological process can cause thunderstorms during two or more consecutive days, because frontal thunderstorms, for example, have a migratory character and do not occur simultaneously on the territory and only along the moving front, and thermos-convective thunderstorms they have a local character, so that in a certain region these phenomena occur only in some sectors, where the degree of air instability favours thermal convection more (CHEVAL, 2003). In fact, the same can be said about the duration or the number of electric discharges, which are much higher in a larger territory than in the area of the observation points (BERBECEL & STANCU, 1970; ȘERBAN, 2010).

RESULTS AND DISCUSSIONS

The average values of the annual number of days with thunderstorms highlight the general characteristics of the distribution of thunderstorms on the territory of Romania. Thus, generally in the mountains and in the piedmont areas, stormy phenomena have the highest frequency, occurring 35-40 days a year. Most days with thunderstorms are located on the western and north-western slopes of the Carpathian Mountains and hills, in advective and frontal situations, as well as on the southern slopes where the thunderstorm activity is also amplified by the action of more intense thermal convection (figure 1).

Above the hilly regions of the country in the western half of the Romanian Plain, in the lower Siret Plain and in the greater part of the Western Plain, more than 35 days with thunderstorms occur annually on average (BLUESTEIN, 1993). The depression of Jijia, the Plain of Miersig and Timiș and the south-eastern part of the country have less than 25-30 days with thunderstorms (NIETO ET AL., 2005). The lowest number of days with thunderstorms (under 25 days) is localized above the Black Sea coast, where the downward movements of the air related to the presence of the vast water basin do not favour the appearance of storm clouds, as above Balți and the Danube Delta.

At the average latitude where Romania is located, depending on the evolution of the processes that generate stormy phenomena, the variation during the year of the number of days with storms shows a maximum in the warm period of the year, being almost non-existent in the cold period (LACKMANN ET ALL, 2017). The percentage monthly frequency of days with thunderstorms highlights the large number of days with thunderstorms from May-August (over 15-20% monthly), with the well-marked maximum in June, the month of the summer solstice (over 20-25%). This periodicity noted in the production of thunderstorms throughout the territory of Romania is the reflection of the general circulation of the atmosphere specific to our country which is grafted onto the concentric and amphitheatre disposition of Romania's mountains, hills and plains, the physical-geographical particularities having a considerable role in the production and diversification of the distribution of thunderstorm activity (DRĂGHICI, 1988).

In general, the number of days with thunderstorms gradually decreases towards the beginning and end of the year, during the cold November-March period thunderstorms are very rare. The high-pressure regime that is established over Eastern Europe starting from October, persisting almost all winter and withdrawing from South-Eastern Europe only in April, is also

for Romania a real dam of dry and cold air, which hinders the penetration humid air and cyclones from the Atlantic Ocean or the Mediterranean Sea basin.

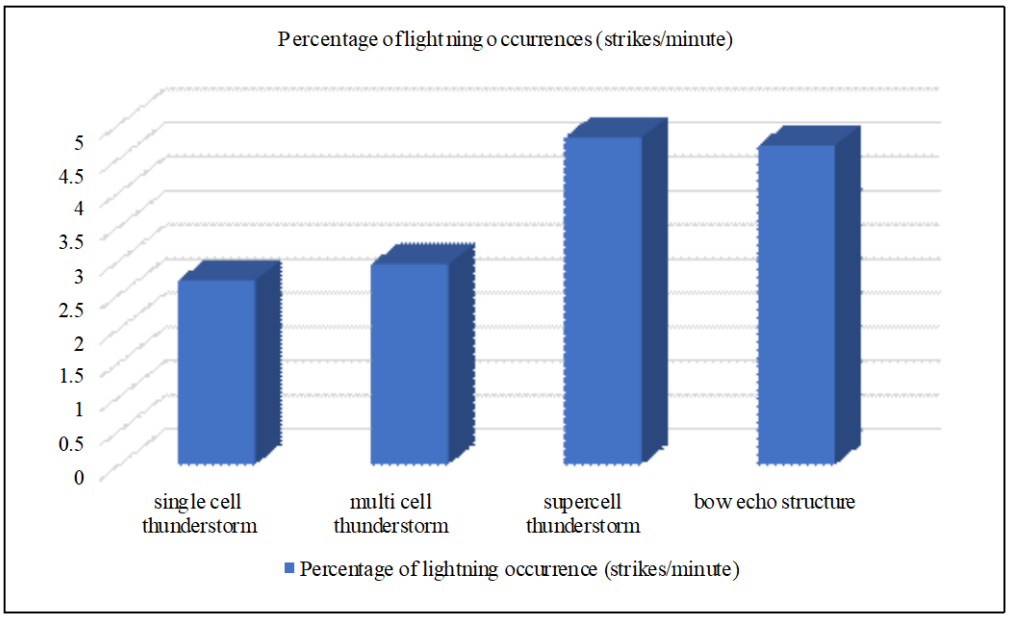

Figure 1. Percentage of lightning occurrences (strikes/minute)

During the winter and in general during the cold period of the year, thunderstorms occur in Romania in exceptional situations, as a result of the sudden replacement of tropical air with a mass of polar air. Such stormy phenomena depend exclusively on the penetration of baric depressions in which there are unstable moist air masses (HOFSTÄTTER ET ALL, 2017).

The same can be said about the stormy phenomena of early spring or late autumn that are related to frontal activity, occurring non-periodically, both day and night. In contrast to this, stormy phenomena during the summer have a predominant frequency during the day, especially in the afternoon, which reflects the special role that thermal convection has in the generation or amplification of thunderstorms (ION-BORDEI, 1983). The annual interval during which it is possible to produce thunderstorms exceeds 150-180 days, which represents over 40-50% of the days of the year. Of course, however, thunderstorms actually occur only in 8-11% of the days of the year (MĂRĂZAN ET AL., 2020). Grouped by monthly decades, the data on the occurrence of thunderstorms on the territory of Romania, regardless of the location of the meteorological stations, the relief conditions and in general the physical-geographical

The second figure (figure 2) shows the maximum in the first or second decade of June (approx. 8-12% of thunderstorms in a year occur on average in this decade), as well as the one in the second decade of July (over 7-11 % of cases); it is also noted the reduction in the frequency of thunderstorms from the first decade of July (6-9%).

The decadal frequencies of thunderstorm production data start to increase gradually from the last decade of April (over 2-3%) reaching, as it was shown, the maximum in the summer months.

The decadal frequencies decrease slightly from the beginning of August, sometimes an increase is observed in the 3rd decade of August. In the second decade of September, the frequency of thunderstorm production data decreases quite suddenly (below 1-2%), so that it remains very high or becomes zero during the rest of the autumn and winter months (MĂRĂZAN, 2018).

conditions, indicate the same periodicity, with maximum frequency in the summer months.

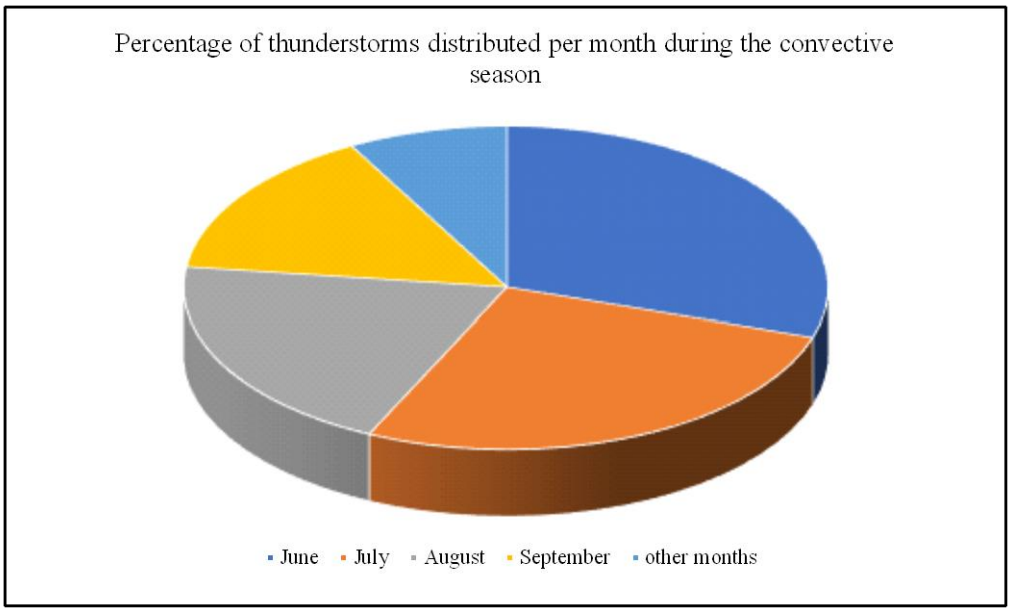

Figure 2. Percentage of thunderstorms distributed per month during the convective season

CONCLUSIONS

Although stormy phenomena develop unevenly on the territory, being related to large-scale and local thermodynamic processes, studied multiannual and as a frequency of production data, the same trend of time distribution of these phenomena can be found everywhere. The general circulation of the atmosphere, the unfolding during the year of the aero synoptic situations' characteristic of different seasons and months, the regime of solar radiation and the characteristics of the active surface with relatively small changes from one year to the next, are associated with the generation of thunderstorm activity in Romania, which is reflected in distribution of the number of days with thunderstorms on the territory.

The regime of stormy phenomena presents particularly interesting aspects and, for example, it should be mentioned that only storms in the warm period of the year are really dangerous, because only they have considerable durations and intensities that endanger the development of activity in the various fields of the national economy.

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