COMPARING THE ANNUAL COURSE OF THUNDERSTORM FREQUENCY IN HUNGARY WITH DATA OBTAINED A HUNDRED YEARS AGO

by

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To the memory of Professor Peczely

A magyarországi zivatargyakoriság évi eloszlásának 100 évvel ezelőtt nyert adatokkal történő összehasonlítása. Az *1968-77*-es évek adatai szerint mutatkozó magyarországi zivatargyakoriság évi menete és a közel *100* évvel ezelőtt kapott, *Héjas E.* által közölt eredmények között főbb vonásaiban nincs nagy különbség (lásd az *1.*, *2.*, és 3. ábrákat!). Úgy tűnik, hogy az általam készített statisztikához használt adatok talán megbízhatóbbak, vagyis a jelenkori "zivatarmérés" szubjektív hibája mintha kisebb lenne, mint a 100 évvel ezelőttié. Talán ez lehet az egyik oka annak, hogy a 33. dekád körül egy kis lokális maximumot találtam. *Héjas E.* azon következtetése, miszerint "a zivatargyakoriság maximuma megelőzi a hőmérséklet júliusra eső maximumát", az 1968-77-es adatok tükrében nem teljesül.

In the main features there is not much difference between the annual course of the thunderstorm frequency in Hungary obtained from the data of the years *1968-77* and the results published by *E. Héjas* nearly a hundred years ago (see Figs. *1*, *2* and *3*). It seems that the recent data are more reliable, as if the subjective error of present-day "thunderstorm measurement" is less than the earlier one taken *100* years ago. Perhaps this may be the reason for the fact that I found a small local maximum about the 33rd decade. *E. Héjas*'s conclusion that "the maximum of thunderstorm frequency precedes the maximum of temperature in July" is not proved in the light of the 1968-77 data.

During the past hundred years, the intensive studying of the annual course of the phenomena of atmospheric electricity has, for certain reasons, fallen into the background. Probably these circumstances explain that relating to the above problem one can only find approaching reports at most, even in the university text-books. In connection with the annual course of the thunderstorm frequency in Hungary - nearly one hundred years ago - ENDRE HEJAS reported rather reliable data. In his book, published in *1898* [*1*], he precisely examined the atmospheric pressure, the wind, the temperature, the vapour pressure and the relative humidity, the cloudiness, the evaporation, the ozone and finally the precipitation on stormy days.

In his examinations he took into consideration what kind of correlation is between storminess and weather situation, and which are those types of weather that lead to the intense developing of thunderstorms. After the satisfactory critical elaboration of data the collected from the territory of the country of that time *E. Héjas* drew several conclusions which are worth reviving and comparing with the data of today.

During statistical examinations it often occurs that the figures of the elements of the samples selected for the evaluation are not the same. In such cases, frequency distributions cannot be directly compared; this is why some sort of mathematical method must be applied to be able to directly compare the distributions. Since the number of the stations examined by me, and that of *E. Héjas*'s stations differ, I transformed *E. Héjas*'s monthly frequency values to the percentage of the annual frequency; so the obtained values (as relative frequencies) are independent from the number of the stations; so there is a possibility of direct comparison. I compared the obtained results to the data counted from the data of the years 1968-77 [2]. This is demonstrated by *Fig. 1*. *E. Héjas*'s results are taken from the tables of pages *108* and *109* of his book. However, I should like to remark that the title writing of the tables is not correct. It is probable that

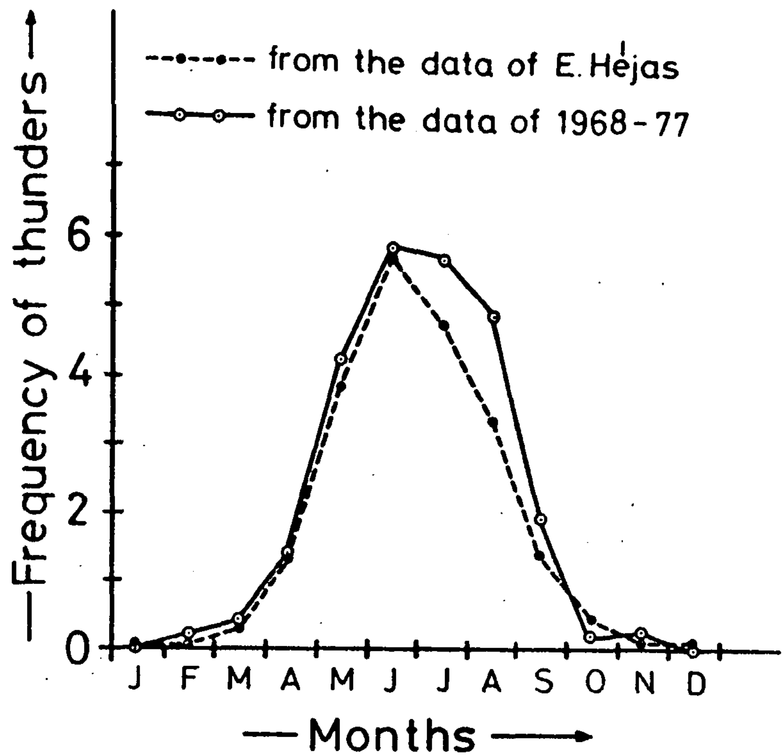

Fig. 1 Annual course of thunderstorms in Hungary in monthly frequencies

E. Héjas mixed the numbers of the thunderstorms with the numbers of the stormy days. For in his table he does not give the monthly and annual sums of the stormy days - as he writes in the title of his table - but the monthly and annual sums of the detected thunderstorms.

E. Héjas also offers further possibility for comparison by having studied the annual course of thunderstorm frequency in taking them to pentads. Among his conclusions, I should like to emphasize that he experienced a decline about the 35^{th} pentad. He brought this into connection with the fact that in the 25-year annual course of temperature there is a well recognizable decline about the 35^{th} pentad. Recognizing of such coincidences is very important, but we have to consider the fact that the mere coincidence is not a reason for us to conclude with absolute certainty that there is a relation of cause and effect between the two variables. For in such cases it often came to light that the two variables depend on the changing of a third (possibly several other) variable(s).

It evidently means that it would be unwise to speak about the fact that the cause of the changing of one variable is the changing of the other one. The above-mentioned decline can be shown on the basis of the *1968-77* data [2]. Since the frequency fluctuations are relatively great in the distribution of pentadic breaking down, so I converted *E. Héjas*'s data into units of ten days (decades), and compared to the decadal distribution counted from the data of the years 1968-77. In order to demonstrate the course of the two distributions, I drew the two distribution "curves" as equally high (by dividing them with the maximum values). It can be seen in

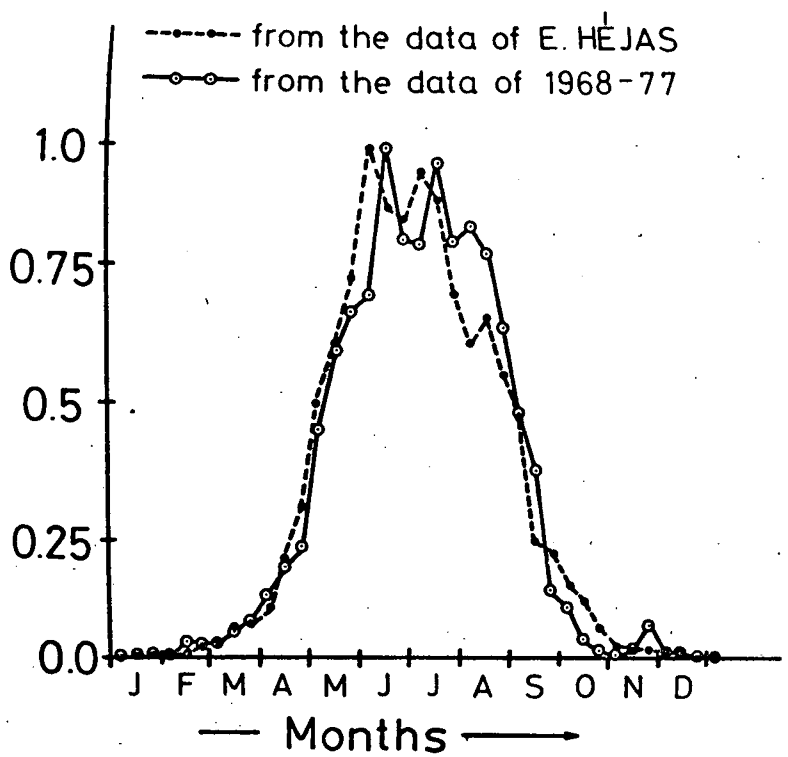

Fig. 2 Annual course of thunderstorms in decadal frequencies (unit = maximal decadal frequency)

the figure that the courses of the two "curves" are almost the same. The above-mentioned decline at the *35th* pentad or *17-18th* decade, which still exists in the case of *15*-day intervals but is no longer so expressed, is recognizable at both distributions, and in the case of a monthly course, it disappears already. In connection with the *2nd figure*, I should like to draw the attention to the fact as well that on the basis of the data of the years 1968-77, at the time of the minor (*5*-, *10*-,or *15*-day) course demonstration toward the end of November (at about the *33rd* pentad) a little local maximum is also recognizable [2].

Further examinations can be done also because there are a couple of stations among those of *E. Héjas* which occur among the stations examined by me, as well. These data are summarized in *Table 1*. It can be seen that, on the one hand, the average number of the thunderstorms is *22.4* for the stations listed by *E. Héjas*; on the other hand, in my statistic the number is *25.02*. The question emerges whether the two data series of *Table 1*, more precisely the two mean values, can be considered significantly different or not. The answer is *NO*. On fulfilling the two-model *t-proof*, it is obtained that the difference between the two values cannot be considered significant even in the case of *10 %* confidency level. This means that the values of *22.4* and *25.02* are practically equal. It is immediately understandable from the fact that in Hungary the standard deviation of thunderstorm frequencies is roughly *3* for one station [2]. For the stations in *Table 1*, so for *Budapest, Eger, Nyíregyháza, Kalocsa and Szeged*, *E. Héjas* gave, beside the annual number of the thunderstorms, even the average monthly thunderstorm

Table 1

The annual sums of thunderstorm frequencies for 12 stations on the basis of the data of *E. Héjas* and of the years 1968-77

Stations	*E. Héjas*'s data	Data of the years 1968-77
Budapest	19.2	18.9
Eger	23.3	25.5
Kalocsa	*21.0*	18.8
Keszthely	23.9	27.5
Komárom	19.2	22.5
Makó	23.0	14.3
Mezöhegyes	20.8	27.6
Nyiregyháza	*24.6*	30.0
Sopron	20.9	27.0
Szeged	*21.6*	32.7
Szolnok	24.4	28.7
Zalaegerszeg	27.2	28.8
Sum total	269.1	302.3
Average for one station	22.4	25.2

The italicized values are arithmetical means of two data published by *E. Héjas*

Table 2

Annual course of thunderstorm distribution with monthly frequencies for 5 stations. Among the data-pairs the first one is always of *E. Héjas*, the second is of 1968-77

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Budapest	0.00	0.04	0.32	1.20	3.92	5.12	3.76	3.20	1.16	0.40	0.00	0.04
(Szabadság-hegy)	0.00	0.40	0.20	1.10	2.80	4.20	3.80	4.40	1.80	0.00	0.20	0.00
Eger	0.05	0.09	0.35	1.61	4.48	6.26	5.18	3.52	1.30	0.30	0.13	0.00
	0.00	0.10	0.50	1.50	3.80	6.40	6.70	4.40	1.70	0.10	0.30	0.00
Nyiregyháza	0.00	0.12	0.42	1.42	3.88	6.79	5.87	3.71	1.13	0.29	0.04	0.00
	0.00	0.20	0.20	1.50	5.90	6.80	7.30	5.10	2.50	0.40	0.10	0.00
Kalocsa	0.00	0.05	0.19	1.00	3.33	5.19	4.62	3.52	1.43	0.62	0.10	0.00
	0.00	0.30	0.40	1.30	2.70	4.40	4.00	3.60	1.70	0.20	0.20	0.00
Szeged	0.09	0.00	0.30	1.70	3.78	3.53	4.35	2.74	1.96	0.65	0.17	0.04
	0.00	0.00	0.80	1.60	6.10	7.60	6.70	7.10	2.00	0.30	0.50	0.00
Average for one station	0.03	0.06	0.32	1.39	3.88	5.74	4.76	3.34	1.40	0.45	0.09	0.02
	0.00	0.20	0.42	1.40	4.26	5.88	5.70	4.92	1.94	0.20	0.26	0.00

Annual sum for one station 21.46
25.18

frequencies. The data used for the annual period are summarised in *Table 2.* The difference between the two distributions can be seen in *Fig. 3.* Here the most apparent thing is that the distribution counted from *E. Héjas*'s data is sharper to the left than the distribution obtained from the data of the years 1968-77. This fact can be observed in *Fig. 1*, and even in *Fig. 2.* From this shift to the left *E. Héjas* concluded - wrongly in my opinion - that "*The majority of our thunderstorms come in early summer, and so the maximum of thunderstorm frequency precedes the maximum of temperature coming in July*". According to *E. Héjas*'s statistics, the number of thunderstorms for one station in Hungary is *22.2.* He himself considered this value only a lower approaching because at several stations only the strongest thunderstorms could be recorded, the farther ones were not taken into consideration. He chose *1.5* as tolerance in the number of thunderstorms (he did not give any reason for his choice). In the chapter "Thunderstorm Statistics", it was average values as about *25* and *26* average value - instead of the above-mentioned number of thunderstorms - which he considered to be the most probable estimated values. These latter values correspond very well with the average values obtained on the basis of the 1968-77 data [2]. *E. Héjas* gives *19.2* thunderstorms annually for the northern slope of *Várhegy* in Budapest, and this is almost equal to the mean value of *18.9* of station on *Szabadsághegy* obtained on the basis of the data of the years 1968-77. In [3,4] I have dealt in greater detail with the identities and differences relating to the spatial distribution of the thunderstorm frequency in Hungary, a swell as to the annual courses of the fulguration and hail frequencies. In the main features there is not a great difference

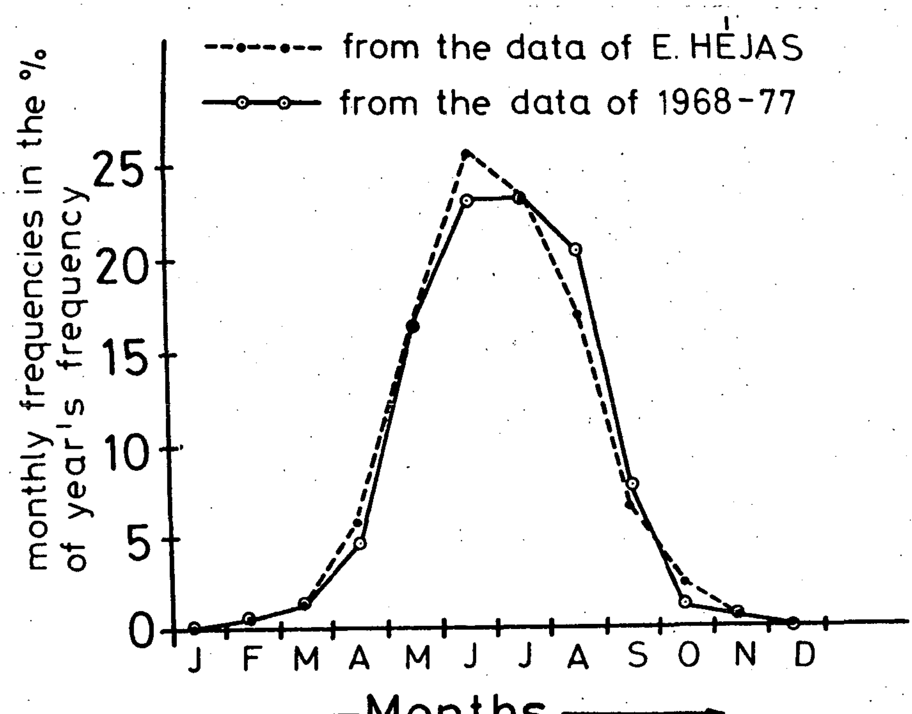

Fig. 3 Annual distribution of thunderstorms on the basis of the data from the towns of Budapest, Eger, Nyíregyháza, Kalocsa and Szeged in monthly frequencies

between the annual course of thunderstorm frequency in Hungary obtained from the data of the years 1968–77 and the results obtained by *E. Héjas* nearly *100* years ago (see *Figs. 1, 2* and *3*).

It seems that the data used for my statistics are perhaps more reliable; that is, it seems as if the subjective mistake was smaller in present day "thunderstorm measuring" than in the one 100 years ago. Perhaps this may be one of the reasons for the fact that I found a small local maximum around the *33rd* decade. *E. Héjas*'s conclusion that "the maximum of thunderstorm frequency precedes the maximum of temperature, falling in July" is not confirmed by the data from 1968–77.

References

[1] *E. HEJAS*: A zivatarok Magyarországon az 1871-től 1895-ig terjedő megfigyelések alapján. (Thunderstorms in Hungary on the basis of the observations extending from 1871 to 1895).- Budapest, 1898.

[2] *M. SZENTPETERI*: A zivatargyakoriság évi menete Magyarországon. (The annual course of thunderstorm frequencies in Hungary.) - Juhász Gyula Tanárképző Főiskola Tudományos Közleményei, Szeged, 1982. 95-104.

[3] *M. SZENTPETERI*: A zivatargyakoriság területi eloszlása Magyarországon. (The regional distribution of thunderstorm frequency in Hungary.) - Juhász Gyula Tanárképző Főiskola Tudományos Közleményei, Szeged, 1982. 105-113.

[4] *M. SZENTPETERI*: Villogás- és jégeső-gyakoriság évi eloszlása Magyarországon az 1968-77-es évek adatai alapján. (The annual distribution of the frequency of fulgurations and hails in Hungary on the basis of the data of the years 1968-77.) - Juhász Gyula Tanárképző Főiskola Tudományos Közleményei, Szeged, 1983. 85-94.