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## WATER VAPOR AND AIR TEMPERATURE ON DAYS WITH THUNDERSTORM IN POZNAŃ

*Abstract:* To establish the relationship between different frequencies of thunderstorm occurrence in given years and diversity of humidity and air temperature there were used data concerning the number of days with thunderstorm, average daily water vapor pressure and air temperature per day in Poznań from 1961 to 1990. Having distinguished years similar as far as the frequency of days with thunderstorm is concerned they were grouped with the help of the Ward method.

*Key words:* day with thunderstorm, air temperature, air humidity.

As presented by the climatologic literature on the issue of humidity and air temperature on days with thunderstorm (Stopa 1964; Kolendowicz 1998) it seems interesting to observe the influence of the amount of water vapor in the atmosphere as well as air temperature on the frequency of thunderstorms occurring within a year.

To establish the relationship between different frequencies of thunderstorm occurrence in given years and diversity of humidity and air temperature there were used data concerning the number of days with thunderstorm, average daily water vapor pressure and air temperature per day in Poznań from 1961 to 1990.

Analyzing the frequency of occurrence of days with thunderstorm at particular values of water vapor pressure and air temperature, probability of thunderstorm occurrence at given water vapor pressure and air temperature or frequency of occurrence of thunderstorm at particular water pressure per year, pressure values were divided into twelve ranges: 0-2.0; 2.1-4.0; 4.1-6.0; 6.1-8.0; 8.1-10.0; 10.1-12.0; 12.1-14.0; 14.1-16.0; 16.1-18.0; 18.1-20.0; 20.1-22.0; >22 hPa. Temperature was divided into 26 ranges: (-23.9)-(-22.0); (-21.9)-(-20.0); (-19.9)-(-18.0); (-17.9)-(-16.0); (-15.9)-(-14.0); (-13.9)-(-12.0); (-11.9)-(-10.0); (-9.9)-(-8.0); (-7.9)-(-6.0); (-5.9)-(-4.0); (-3.9)-(-2.0); (-1.9)-0.0; 0.1-2.0; 2.1-4.0; 4.1-6.0; 6.1-8.0; 8.1-10.0; 10.1-12.0; 12.1-14.0; 14.1-16.0; 16.1-18.0; 18.1-20.0; 20.1-22.0; 22.1-24.0; 24.1-26.0; 26.1-28.0°C.

Over the analyzed period of years the days with average water vapor pressure from 4.1 to 12.0 hPa were the most frequent (over 65% of days per year). The average water vapor pressure is very rarely lower than 2.0 hPa or higher than 16.0 hPa. Days with those rare values constituted less than 7% of days per year. The higher values of average water vapor pressure per day the bigger probability of thunderstorm occurrence. Days with thunderstorm do not occur at the water vapor pressure equal or smaller than 4.0 hPa, however at values higher than 22.0 hPa the probability of thunderstorm occurrence is 75%. Thunderstorms occur most frequently (66%) on days with the vapor pressure from the range 12.1 to 18.0 hPa.

Analyzing the changes of average daily air temperature over the given period of time it was noticed that for 70% of days the temperature was from 0.1 to 18.0°C. Days with thunderstorm in Poznań occur at temperature higher than 0°C. It was also observed that probability of thunderstorm occurrence at particular average daily air temperature increases along with the increase of temperature. The probability is the highest (around 20%) for temperature higher than 20.0°C. Days with thunderstorm occurred most often in the analyzed period of time at average temperatures from the range of 12.1 to 22.0°C, constituting over 77% of all days with thunderstorm.

The analysis leads to the conclusion that there is a certain relationship between the number of days with thunderstorm and frequency of occurrence of days with average daily values of water vapor pressure and air temperature. Most remarkably there is a considerable difference of probability of days with thunderstorm occurrence at the highest values of water vapor pressure and air temperature. It suggests that there is stronger relationship between thunderstorm occurrence and water vapor pressure than between thunderstorm occurrence and air temperature.

Number of days with thunderstorm per year ranges from 7 in 1989 to 32 in 1961, and it changes strongly year by year (Fig. 1). The trend line marks decreasing tendency of days with thunderstorm in the examined period of 30 years.

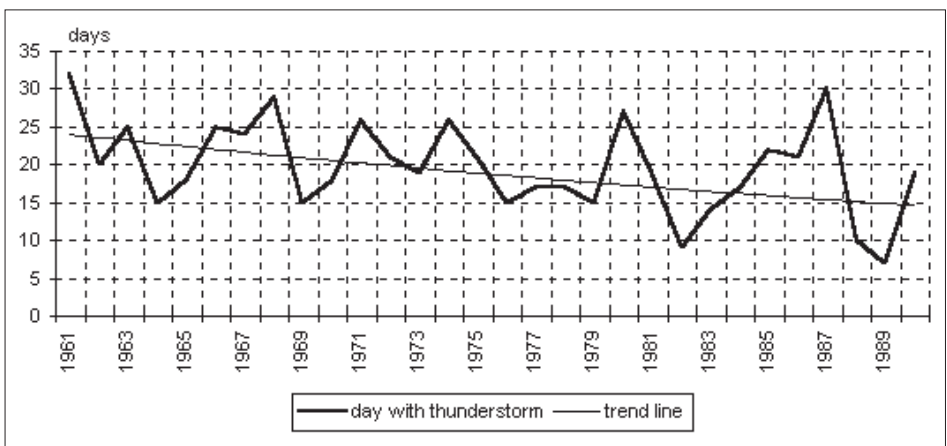


Fig.1. Number days with thunderstorm in Poznań in the years 1961-1990.

Distinguishing similar years as far as the frequency of occurrence of days with thunderstorm is concerned there was applied Ward method. Grouping based on the analysis of the number of days with thunderstorm with a given average daily air temperature would not lead to univocal differentiating among the distinguished groups of years. Moreover, as the relationship between the thunderstorm occurrence and the water vapor pressure was stronger than air temperature, we took as the basis of grouping the number of days with thunderstorm at average daily water vapor pressure from the previously assumed value ranges.

Having analyzed the obtained dendrogram there were six-year groups distinguished (Fig. 2). The groups differ not only as far as the frequency of thunderstorm occurrence at given values of water vapor pressure is concerned but also in relation to the yearly sums of thunderstorm days.

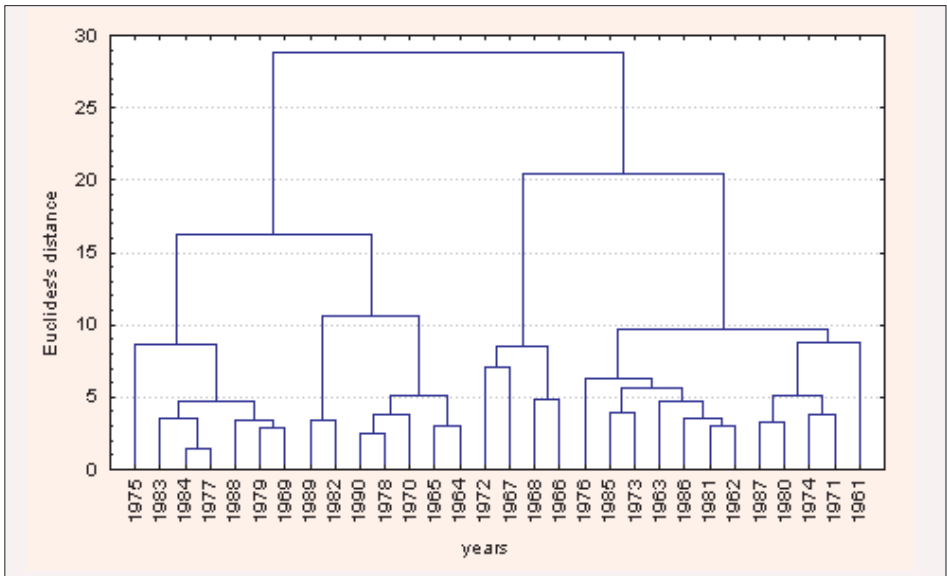


Fig.2 Dendrogram of grouping with the Ward method.

The distinguished groups of years are:

Group 1 (years 1982, 1989) – less than 10 days with thunderstorm per year, 8 days on the average.

Group 2 (years 1969, 1975, 1977, 1979, 1983, 1984, 1988) – from 10 to 21 days with thunderstorm per year, 16.5 on the average.

Group 3 (years 1964, 1965, 1970, 1978, 1990) – from 15 to 19 thunderstorm days per year, 17.4 on the average.

Group 4 (years 1962, 1963, 1973, 1976, 1981, 1985, 1986) from 15 to 25 days with thunderstorm per year, 20.1 on the average.

Group 5 (years 1966, 1967, 1968, 1972) – from 21 to 29 days with thunderstorm per year, 24.8 on the average.

Group 6 (years 1961, 1971, 1974, 1980, 1987) – from 26 to 32 days with thunderstorm per year, 28.2 on the average.

Comparing the distinguished groups of years we examined the following differences between the average values for the given period of 30 years and the values characteristic of the six groups, taking into consideration the preassumed ranges of water vapor pressure and air temperature:

1. differences of the number of days with a given water vapor pressure and air temperature,
2. differences of the number of days with thunderstorm,
3. differences of probability of occurrence of days with thunderstorm.

The results of the analysis lead to the following conclusions:

Number of days with thunderstorm in a given year depends on the frequency of occurrence of days with average daily water vapor pressure higher than 4 hPa. The higher the water vapor pressure is the more often days with thunderstorm occur.

Air temperature is less connected with the occurrence of thunderstorms than its humidity.

The essential relationship with the occurrence of days with thunderstorm can be noticed in the probability with which these days occur at certain average daily water vapor pressure volumes and average daily air temperature. It must be pointed out that despite the increase of probability of occurrence of days with thunderstorm along with the growth of water vapor pressure or air temperature, its values differed significantly in particular years.

The issue of diverse probability of occurrence of days with thunderstorm will be the subject of another paper.

## References

- Kolendowicz L., 1998, *Zjawiska burzowe w Polsce a warunki synoptyczne*, Bogucki Wydawnictwo Naukowe, Poznań, 1-87.
- Stopa M., 1964, *Warunki meteorologiczne sprzyjające powstawaniu burz w różnych masach powietrza*, *Przeł. Geofiz.*, 9, 1, 67-75.

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