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SOME ASPECTS OF THE WIND IN THE NORTHERN AREA OF THE DEPRESSION OF TRANSSYLVANIA

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Összefoglalás - A jelen tanulmány az Erdélyi Medence északi részén előforduló talajmenti és magaslati szél egyes vonásait mutatja be. A szél paramétereinek az elemzése 5 meteorológiai állomás (Torda, Kolozsvár, Dézs, Beszterce és Marosvásárhely) és a Kolozsvári Aerológiai Állomás által szolgáltatott, 1961 és 1980 között feljegyzett adatok alapján történt. A szél irányának és sebességének az évi, évszaki és havi középértékeit a talajszinten és az 5 standard izobár szinten számítottuk ki. A felszín morfológiai sajátosságai és ennek a Kárpátok vonulatához viszonyított elhelyezkedése meghatározza a talajmenti szél paramétereinek regionális jellemzőit. A Kárpátok vonulatának a légmozgásra gyakorolt hatása körülbelül 3000 m magasságig érződik, fölötte a nyugati széljárás jellemző.

Summary - The study presents some aspects of the ground level and altitudinal wind in the northern area of the Depression of Transsylvania. The analysis of the wind parameters is based on the data provided by 5 meteorological stations (Turda, Cluj-Napoca, Dej, Bistriţa and Târgu-Mureş) and the Cluj-Napoca Aerological Observatory, covering the interval between 1961-1980. The annual, seasonal and monthly average values of the direction and speed of the wind at ground level and at the five standard isobaric levels have been calculated. The regional differences of the wind parameters at ground level are affected by the morphologic peculiarities of the area and by its position in the vicinity of the Carpathian bow. In the altitude the influence of the Carpathians upon the circulation of the air is felt as high as 3000 m. Above this level the western circulation is predominant.

Key-words: direction and speed of the wind, morphology of the relief, Carpathian bow, standard isobaric levels

INTRODUCTION

The studied region includes the hilly area on the northern part of the Mureş, between Deda and the affluence of the Arieş, limited by the Apuseni Mountains and the Eastern Carpathians (*Fig. 1*). The transition towards the two adjacent mountain regions is made gradually through some hills and submontane and intra-hill depressions.

Fig. 1 Location of meteorological stations in the studied region

The different features of the wind in this region are determined by the elevation and the position of the relief related to the direction of the western masses of air, their movement being favoured at certain levels by the occurence of some channels, cols and wide valleys. Thus, above the ground level the movement of air currents is directed by some wide cols between isolated ridges which in the north-west make the connection between the Apuseni Mountains and the Eastern Carpathians (*Fig. 1*).

At higher levels, between 600 and 1000 m, the penetration of the masses of air is facilitated by the lower elevation of the peaks in the Apuseni Mountains. Massiveness and the higher elevation in the central part of the Apuseni Mountains make it more difficult for the masses of air to penetrate into the Depression of Transsylvania, which generate the shelter peculiarities of the wind system different from those of the periferic regions.

Due to the barrier made up by the Eastern Carpathians the masses of air from the eastern part of the continent reach the territory of the depression only if they are considerably developed in altitude. From the south, the flow of atmospheric currents along the Olt Valley occurs rather infrequently. Neither do the masses of air penetrate into the depression along the Mureş Valley very often.

As we ascend in altitude, the wind system is less influenced by the morphologic peculiarities of the relief or by the position of the territory related to the Carpathian bow.

The study of the wind system in the northern part of the Depression of Transsylvania was carried out through the detailed analysis of the parameters describing the direction and intensity of the wind, including their variations in time and space. Consequently, we analysed and interpreted the data recorded between 1961-1980, resulting from five meteorological stations (Turda, Cluj-Napoca, Dej, Bistriţa and Târgu-Mureş) and from the only aerological observatory in the Depression of Transsylvania (Cluj-Napoca), which is representative for the whole studied region.

THE GROUND LEVEL WIND

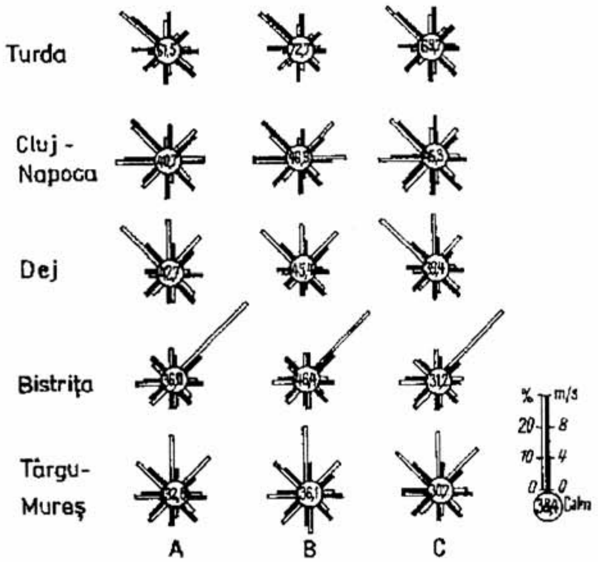

Fig. 2 The annual (A) and seasonal (B-winter; C-summer) frequency (%) and the mean speed (m/s) of the wind at 10 m a.g.l.

The direction of the wind. Taking into account its position within the Carpathian relief, the studied region is under the influence of the predominantly western circulation. On this background there occur, however, some local changes in the direction of the wind, imposed by the peciuliarities of the subjacent surface and especially by the general configuration of the relief. Moreover, on the margins of the region the situation is complicated by a breeze-like circulation from the mountains. Observing the annual frequency of the directions of the wind, we can notice that on the western margin the westerlies represents 31.2 % of the total at Cluj-Napoca and 19.5 % at Turda (*Fig. 2A*). The percentage of the different directions depends on the position and the configuration of the relief of the area where the meteorological stations are situated (*Fig. 1*). In the Depression of Turda the most frequent is the north-western direction (Turda 15.7 %), while in the valley of the Somesul Mic is the western (Cluj-Napoca 12.1 %). On the eastern margin a transfer of the mountain-origin masses of air is quite noticeable. This phenomenon is emphasized by the predominance of the north-eastern wind (Bistriţa 29.8 %). The same phenomenon was noticed at the Odorheiu-Secuiesc meteorological station situated in the same eastern part of the depression, but outside the studied region.

Within the plateau, the predominant direction of the wind is rather varying, depending on the orientation of the major valleys. Thus, along the valley of the Mureş between Târgu-Mureş and Ludus, the circulation is directed to the west and east. All the other directions show diminished frequency (under 10 %). The same influence of the configuration of the relief upon the channelling of the masses of air can be mentioned in the case of the Mureş Valley upstream Târgu-Mureş, and of the Somes Valley in the vicinity of Dej, where almost all the circulation is directed from the north quadrant (Târgu-Mureş 41 %, Dej 40.1 %).

The seasonal frequency of the direction of the wind, except for a few cases, shows the same features as in the case of the annual frequency. That is to say, in winter when the circulation is marked by the presence of the Euroasian continental anticyclone, a slight increase of the frequency in the occurence of the north-eastern wind can be noticed. The phenomenon is more visible on the eastern edge where the frequency of the north-eastern wind is over 12% (*Fig. 2B*).

We should mention that during this season the north-eastern direction shows a higher percentage in February. Also, a relatively high frequency occurs in the case of the western winds during winter. The explanation most probably lies in the intensified cyclonic activity from the northern basin of the Atlantic Ocean.

In spring, like in winter, the predominant directions are those from the north-east, in the northern and eastern parts of the region and from the west in the rest of the region. Beginning in March or April, following the strengthening of the Azoric anticyclonic dorsal towards the east and south-east of the continent. The frequency of the western and north-western directions increases, mainly in the western part of the region, going as high as over 20 %. The increased frequency of these directions can be felt in the appreciable growth in the quantity of rainfall compared to the preceding season. The late spring frosts and low temperatures, which are rather frequent on the eastern margin especially in the first part of the season can be explained by the invasion of cold air, by the north-eastern winds that have a remarkable frequency (34.4 % at Bistriţa).

In summer the western wind prevails with a high frequency of the western and north-western directions, the percentage of which ranges between 13 and 16 % on the eastern edge and 20 to 30 % in the rest of the territory (*Fig. 2C*).

In autumn, once the Azoric anticyclone has reduced its activity, the western circulation diminishes and the northern and north-eastern winds are intensified reaching frequencies almost as high as in winter.

The calm intervals. The influence of the peculiarities of the relief is well mirrored in the frequency of the calm intervals. Thus, in the region which is sheltered from the prevailing western circulation, the calm intervals were recorded with a very high percentage (Turda 61.5 %), while in the proximity of the Eastern Carpathians the currents of air from the mountain region considerably diminish the annual frequency of the calm (Bistriţa 36 %). The great ventillation along the valleys causes lower values of the calm (Târgu-Mureş 32.2 %, Cluj-Napoca 40.7 %). During the year, the frequency of the calm intervals displays a major maximum value in October, not very much different from the value recorded in December (*Fig. 3*).

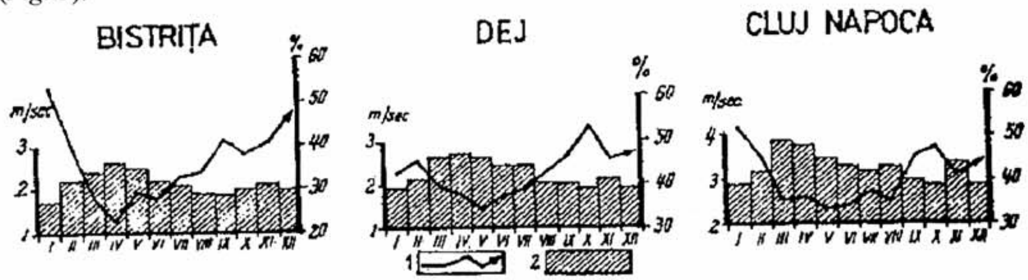

Fig. 3 Monthly variations of the mean wind speed (1) (m/s) and calm intervals (2) (%) at 10 m a.g.l.

On the eastern margin of the region the major maximum value is usually recorded in December and January. The main minimum value occurs in April, sometimes even earlier (March) in the western part of the region and somewhat later (April, May) in the northern and eastern parts.

The speed of the wind. This is a varying parameter depending on the general atmospheric circulation and on the local surface of the relief (sheltered region or exposed to the wind). The mean annual speed in the studied region ranges between 2.0 and 3.6 m/s. On the margins of the area the descent of the currents from the mountains causes the intensity of the wind to be somewhat higher than in the plateau (Bistriţa 3.6 m/s, Cluj-Napoca 3.2 m/s, Târgu-Mureş 2.4 m/s). Generally, the highest mean annual speed is recorded on the predominant directions (*Fig. 2*).

The speed of the wind shows monthly and seasonal variations, resulting in an intensified spring period and a reduced late summer and early autumn period. In winter the speed of the wind is diminished, in general under 3 m/s. However, higher speeds do occur on the prevailing directions. That is to say, the speed of the north-western wind exceeds 5 m/s at Cluj-Napoca and Turda (*Fig. 2B*). In spring, once the cyclonic circulation has intensified its activity, the mean speed of the wind goes up considerably, in most of the cases the recorded values were 1 m/s higher than in winter. Consequently, all the directions show high speeds, a fact that is not encountered in the other seasons. In summer the mean speeds drop with 0.5-1 m/s related to the previous season, often being under 3 m/s. In autumn the mean values go up at the beginning with October in the east of the region and in November in the rest of the area.

In comparison with the other seasons, in autumn the mean speeds of the wind are more reduced (*Fig. 3*).

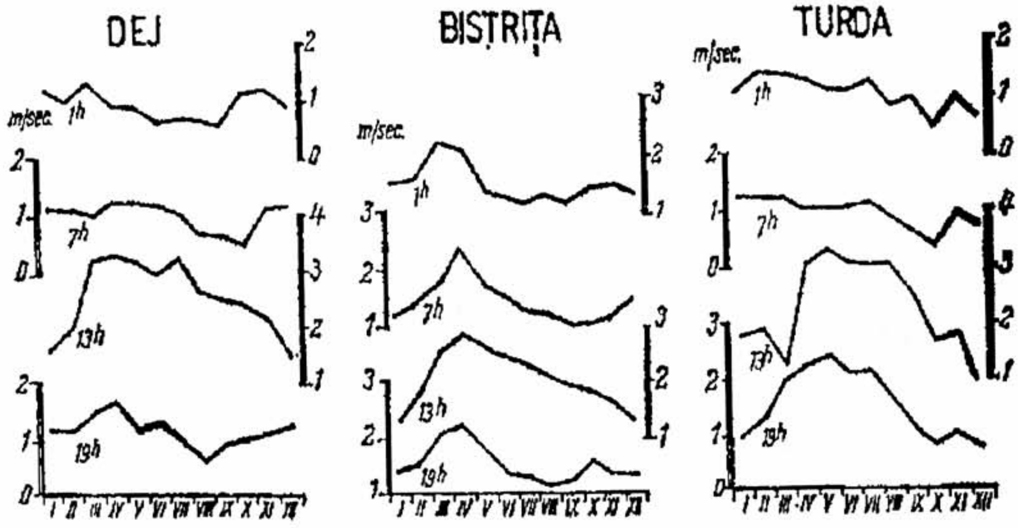

Fig. 4 The evolution of the wind speed recorded at the four climatological observation hours

The daily oscillations of the mean speed of the wind display a maximum value recorded around noon when the isolation is strong, the thermal convection is developed and the coefficient of turbulence is high, and there is a minimum during the night, toward morning when the stationary thermal stratification of the air is predominant and the temperatures are the lowest. The daily evolution of the wind speed along the year is characterised by two intervals of intensified activity: in spring, in March and April, and in autumn in November; however, this is less intense and more visible on the western margin of the region (*Fig. 4*).

In spring, which is the most agitated season, the mean speed reaches 3-4 m/s around noon, while in autumn the recorded values are 1-2 m/s lower. The daily annual minimum value occurs during summer nights, when the speed of the wind exceeds 1 m/s on the margins of the area, but stays under this value in the plateau.

From the analysis of the mean wind speeds, calculated for 5 categories, we could draw the conclusion that during the year the highest frequency (50-70 %) is for the very weak currents (under 1 m/s), while the lowest (under 3 %) is for a speed range between 11 and 15 m/s (*Fig. 5*). Wind speeds of more than 15 m/s are of a reduced frequency (under 0.5 %) or are non-existent.

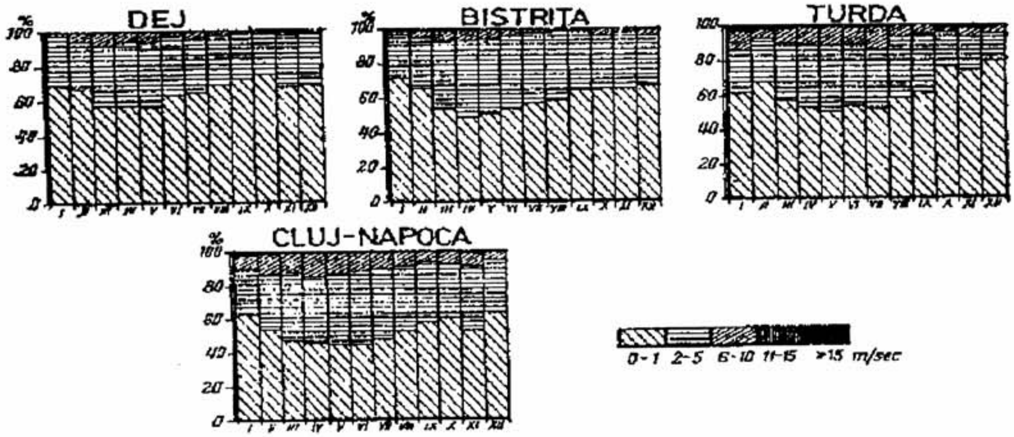

Fig. 5 Frequency (%) of the mean wind speeds

THE ALTITUDIAL WIND

Its characteristics are based on data obtained from the radiosondes recorded at the Cluj-Napoca Aerological Observatory. They were determined at the standard isobaric levels: 950 hPa (540 mgp medium height), 850 hPa (1480 mgp), 700 hPa (3040 mgp), 500 hPa (5620 mgp) and 100 hPa (16250 mgp), at 00 UTC.

The first thing to be remarked is that at all the mentioned levels the maximum frequency was on the western direction. The 850 hPa level was an exception, as in this case the north-western direction was predominant (*Fig. 6*). The phenomenon was more and more obvious as the elevation grows, due to the fact that as we ascend, the influence of the earth's surface decreases diminishing the effect determined by the configuration of the relief.

Secondly, we should mention the variation in frequency of the south-western direction at different isobaric levels. Thus, due to the barrier effect of the Apuseni Mountains, the frequency of the wind blowing from the south-west was reduced (15-16 %) at lower levels. Beginning with the 700 hPa level, the percentage of the south-western wind increases considerably until it reaches values that are specific to the western direction (21-27 %). In concordance with the altitudinal intensification of the zonal hemispheric vortex, the percentage of the western wind increases from 58.3 % at 950 hPa to 77.3 % at 100 hPa.

Following the monthly variation of the frequency of the wind, we can notice that it has an irregular feature at all the isobaric levels. However, in the case of western directions the frequency is higher in the latter half of the year, while eastern winds occur more frequently in the former half (*Fig. 7*).

As for the mean speeds of the altitudinal wind, we have noticed that the highest values occur in the case of the predominant directions. Including the 500 hPa level, the highest values of

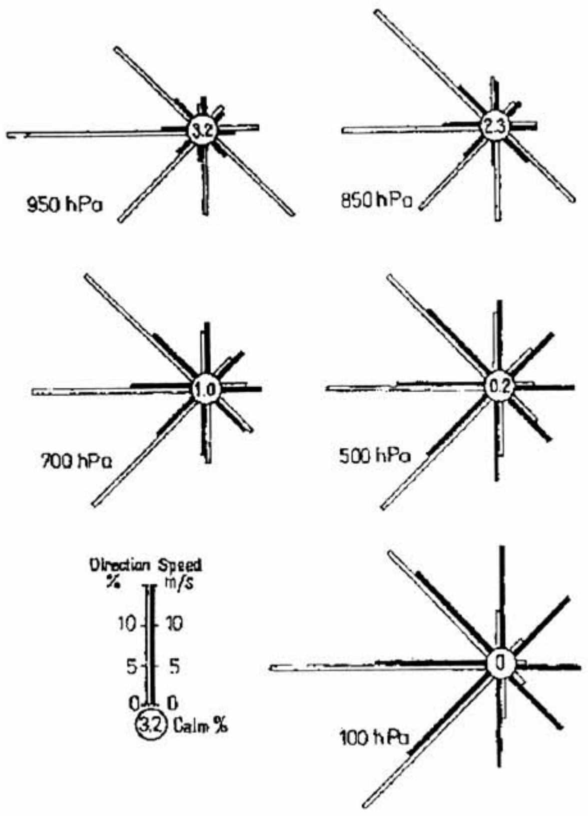

Fig. 6 The annual frequency (%) and mean speed (m/s) of the altitudinal wind, at 00 UTC hours, as recorded by the Cluj-Napoca Aerological Observatory radiosondes

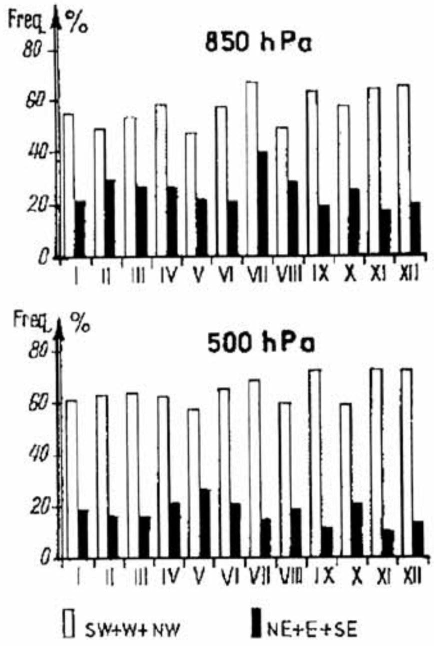

Fig. 7 The monthly variation of the altitudinal wind frequency (%) for the western and eastern quadrants

the wind speed occur on the north-western direction (5.4 m/s at 950 hPa, 6.9 m/s at 850 hPa, 9.5 m/s at 700 hPa), while at the 100 hPa level they were recorded on the south-western (16.6 m/s) and western (16.3 m/s) directions. The lowest speeds are specific to the eastern winds (*Fig. 6*).

With regards to the monthly variations of the mean speed of the altitudinal wind, the highest values were recorded in winter, and the lowest in late

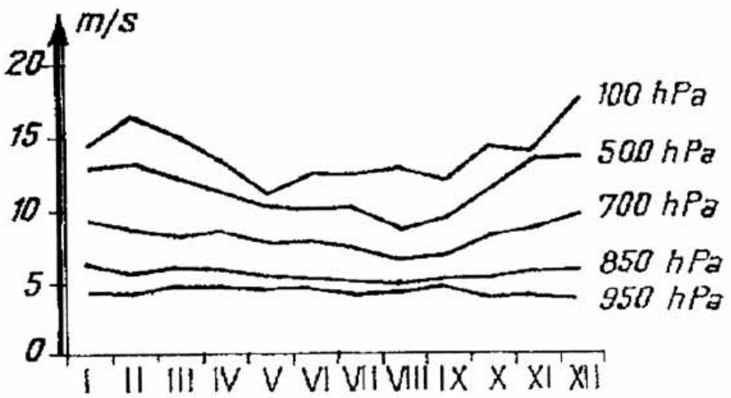

Fig. 8 The monthly variation of the mean speed (m/s) of the altitudinal wind

summer (*Fig. 8*).

The annual amplitude of the mean speeds increases with the altitude, from 0.9 m/s at 950 hPa to 6.5 m/s at 100 hPa. The frequency of the calm intervals is insignificant in the altitude: 3,2% at 950 hPa, 1.0% at 700 hPa, while at the 500 hPa level it is virtually absent.

CONCLUSIONS

The geographic position and the morphologic features of the studied region are essential factors that determine the spatial variations of the wind parameters.

The influence of the Carpathian bow upon the circulation of the air can be felt as high as roughly 3000 m. Above this level the predominant circulation is from the west.

The fragmentation of the Carpathian bow in the north-west of the studied region facilitates the penetration of oceanic masses of air at low levels (under 1000 m), which are mainly directioned towards the eastern margin of the region.

The regional peculiarities of the wind system are reflected in the diversified landscape of the area.

REFERENCES

Bâzâc, Gh., 1983: *Effects of relief on the most important parameters of the climate of Rumania* (in Rumanian). Editura Academiei, Bucureşti.

Sorocovschi, V. and Tudoran, P., 1983: Les particularites du regime eolien dans la Depression de la Transylvanie. *Rev. Roum. Geol. Geophys. et Geogr., Geographie, Tome 26*, Bucureşti, 51-60.

Tilinca, Z., Fărcaş, I., Mihăilescu, M., 1976: *Contribution to the synoptic study of foehn in Apuseni Mountains* (in Rumanian). Studii şi cercetări, 1/2, Meteorologie, I.M.H., Bucureşti.

x x x, 1983: *Geography of Romania, I, Physical geography* (in Rumanian). Editura Academiei, Bucureşti.