CONSIDERATIONS REGARDING THE NEBULOSITY REGIME AND CLOUDS FREQUENCY AT THE METEOROLOGICAL STATIONS FROM BÂRLAD DRAINAGE BASIN DURING 1961-2010

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Key words: clouds, evolution, frequency, nebulosity, trend.

ABSTRACT:

Calculations based on long strings of observations (1961 - 2010) have shown that average values of total nebulosity in the 6 locations from Barlad hydrographic basin (Negresti, Vaslui, Barlad, Tecuci, Oncesti si Plopana) have ranged between 5.9 and 6.3 tenths. For the agricultural character of the Barlad hydrographic basin a major importance is held by the genetically related clouds type which has the largest share in rainfall production (T. Bradu, 2004). To give expression drawn graphs I made pairs of clouds types: *altostratus (As) and nimbostratus (Ns)*, with long-term precipitations falling as rain, snow and ice pellets, *stratocumulus (Sc) and stratus (St)*, generally producing precipitations as rain, snow and drizzle, and *cumulus clouds (Cu)* that can evolve into *cumulonimbus (Cb)*, with rain falling in the aversion form.

1. Introduction

The clouds produce significant changes in the evolution of the other climate elements (the duration of the sun shine, solar radiation, temperature, air humidity, atmospheric precipitation, through water amounts remained in the mass of clouds in vapor form, water drops or ice crystals etc.), through their size and form, life duration and their constitution (L. Apostol, 2004; D. Precupanu-Larion, 1999). The more significant the extension on the celestial vault and the vertical thickness of the clouds are, and their presence longer, the higher the value of the nebulosity will be. (D. Mihăilă, 2006).

Being an element which, in most cases, determines the weather in the area over which exists, the cloud is one of the most important phenomena subjected to meteorological observation. Through their quantity, form, height, associations or evolution, the clouds are a valuable indicator of thermodynamic processes that dominate in their area of existence. Further more, clouds affect the economic activity of people through their associated phenomena, making more difficult or endangering a range of activities from various fields (O. Machidon, 2009).

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Nebulosity depends directly proportional on the air humidity, conditioning the regime to in its turn of other climate elements (V. Budui, 2009).

2. Data and methods

The paper is based chiefly on factual material represented by data measured during 1961 – 2010. These are summarized in tables and the interpretation is supported by graphs. The datasets used came from the weather stations that functioned continuously during 1961 – 2010 (Negreşti, Vaslui, Bârlad, Tecuci). In order to make an accurate description of the nebulosity's features and of the clouds from territory of Bârlad drainage basin, data coming from meteorological stations Oncesti and Plopana were analyzed, although the observation periods were smaller, respectively during 1961-1999 at Oncesti and 1964-1999 at Plopana.

For the purpose of determining the nebulosity evolution graphs were made for the period 1961 - 2010. To establish a trend we have used the moving averages method with a 10-years period, delayed by one year, drawing the trend line by means of EXCEL's special feature.

3. Results

The average values of the total nebulosity from the six locations in Bârlad drainage basin ranged between 5.9 and 6.3 tenths (table 1, figure 1). When analyzing these statistic data one can observe an unspectacular distribution of the total nebulosity, fact that can be explained by the relatively small spatial extent of the studied area. The annual average values increased slightly from the north (6.2 tenths at Negreşti) towards south at Barlad (6.3 tenths) and then decreased, so that the annual average reached at Tecuci at 5.9 tenths.

In spring and autumn, the nebulosity has intermediary values that increase towards the winter and decrease towards the summer, having in spring rather higher values than in autumn (table 1, figure 1).

The December's maximum (7.0 - 7.6 tenths) is determined both by the high frequency of the barometric depressions, within which the upward movement of the air results in water vapor condensation, thereby generating cloud systems, as well as the thermal inversions which leads to the remaining of dense air masses resulting in a higher frequency of radiation fogs accompanied by stratiform clouds on the valley corridors and in the concavities of the relief (D. Mihăilă, 2006). Barometric maximums were recorded in August, which caused atmospheric stability that is not favorable to the formation of cloud systems; the subtropical or continental warm air advections, which produced high temperatures, have reduced the possibility of air saturation with water vapors and implicitly led to the reduction of the sky's coverage with clouds; this month was characterized by the lowest values of nebulosity recorded during a year (4.2 - 4.8 tenths).

Table 1. The monthly and annual averages (tenths) of the total nebulosity

Negrești(1966-2010)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	X I	
1	6,9	6,9	6,2	5,5	4,6	4,3	3,8	3,4	4,0	4,9	6,6	7,4	**5,4**
7	7,8	8,0	7,7	6,9	6,0	5,5	4,9	4,7	5,9	7,0	7,9	8,0	**6,7**
13	7,5	7,4	7,2	7,2	6,7	6,4	5,9	5,2	5,9	6,2	7,4	7,7	**6,7**
19	6,7	6,6	6,7	7,1	6,5	6,3	5,6	5,3	5,3	4,9	6,5	6,9	**6,2**
Media	**7,2**	**7,2**	**7,0**	**6,7**	**5,9**	**5,6**	**5,0**	**4,6**	**5,3**	**5,7**	**7,1**	**7,5**	**6,2**

Plopana(1964-1999)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	6,7	6,8	6,1	5,4	4,8	4,2	3,8	3,5	3,8	4,8	6,4	7,0	**5,3**
7	7,5	7,7	7,4	6,7	5,7	5,0	4,4	4,3	5,2	6,3	7,5	7,5	**6,3**
13	6,9	6,9	6,9	7,0	6,4	5,9	5,5	4,8	5,4	5,8	7,0	7,0	**6,3**
19	6,2	6,3	6,4	7,0	6,3	6,0	5,3	5,2	4,7	4,5	6,3	6,6	**5,9**
Average	**6,8**	**6,9**	**6,7**	**6,5**	**5,8**	**5,3**	**4,8**	**4,4**	**4,8**	**5,3**	**6,8**	**7,0**	**5,9**

Vaslui(1961-2010)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	7,0	6,8	6,2	5,3	4,5	4,1	3,6	3,2	3,9	4,8	6,7	7,4	**5,3**
7	7,7	7,9	7,4	6,7	5,6	5,1	4,5	4,4	5,5	6,8	7,9	8,0	**6,5**
13	7,3	7,2	7,1	7,0	6,5	6,0	5,5	4,9	5,5	6,0	7,3	7,5	**6,5**
19	6,7	6,5	6,5	6,8	6,2	6,0	5,3	4,9	4,8	4,7	6,6	7,0	**6,0**
Average	**7,2**	**7,1**	**6,8**	**6,4**	**5,7**	**5,3**	**4,7**	**4,4**	**5,0**	**5,6**	**7,1**	**7,5**	**6,1**

Oncești(1961-1999)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	6,8	7,0	6,3	5,3	4,8	4,2	3,8	3,4	3,8	4,8	6,5	7,2	**5,3**
7	7,6	7,6	7,6	6,9	6,0	5,3	4,7	4,4	5,4	6,7	7,8	7,7	**6,5**
13	7,1	7,2	7,2	7,1	6,7	6,1	5,7	4,9	5,5	5,9	7,2	7,2	**6,5**
19	6,6	6,5	6,5	6,9	6,6	6,2	5,4	5,1	4,8	4,5	6,5	6,7	**6,0**
Average	**7,0**	**7,1**	**6,9**	**6,6**	**6,0**	**5,4**	**4,9**	**4,5**	**4,9**	**5,5**	**7,0**	**7,2**	**6,1**

Bârlad(1961-2010)

Ora	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	6,9	7,0	6,3	5,8	4,9	4,2	3,7	3,5	3,6	4,9	6,5	7,4	**5,4**
7	7,5	7,7	7,5	7,0	6,4	5,4	4,8	4,6	5,0	6,6	7,9	8,1	**6,5**
13	7,5	7,3	7,6	7,7	7,6	6,9	6,3	5,8	5,7	6,3	7,7	7,7	**7,0**
19	6,5	6,6	6,8	7,3	7,1	6,7	5,5	5,4	5,0	4,8	6,5	7,1	**6,3**
Average	**7.1**	**7.2**	**7.1**	**7.0**	**6.5**	**5.8**	**5.1**	**4.8**	**4.8**	**5.7**	**7.2**	**7.6**	**6,3**

Tecuci(1961-2010)

Ora	Month												Anual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	6,9	6,7	5,9	5,1	4,3	3,8	3,3	3,2	3,7	4,6	6,6	7,4	**5,1**
7	7,6	7,7	7,3	6,4	5,6	4,8	4,2	4,0	5,2	6,3	7,9	7,9	**6,2**
13	7,3	7,1	6,8	6,8	6,4	6,0	5,3	4,7	5,3	5,6	7,2	7,5	**6,3**
19	6,8	6,4	6,3	6,7	6,3	6,0	5,2	5,1	4,8	4,4	6,3	6,9	**5,9**
Average	**7,1**	**7,0**	**6,6**	**6,3**	**5,6**	**5,1**	**4,5**	**4,2**	**4,7**	**5,2**	**7,0**	**7,4**	**5,9**

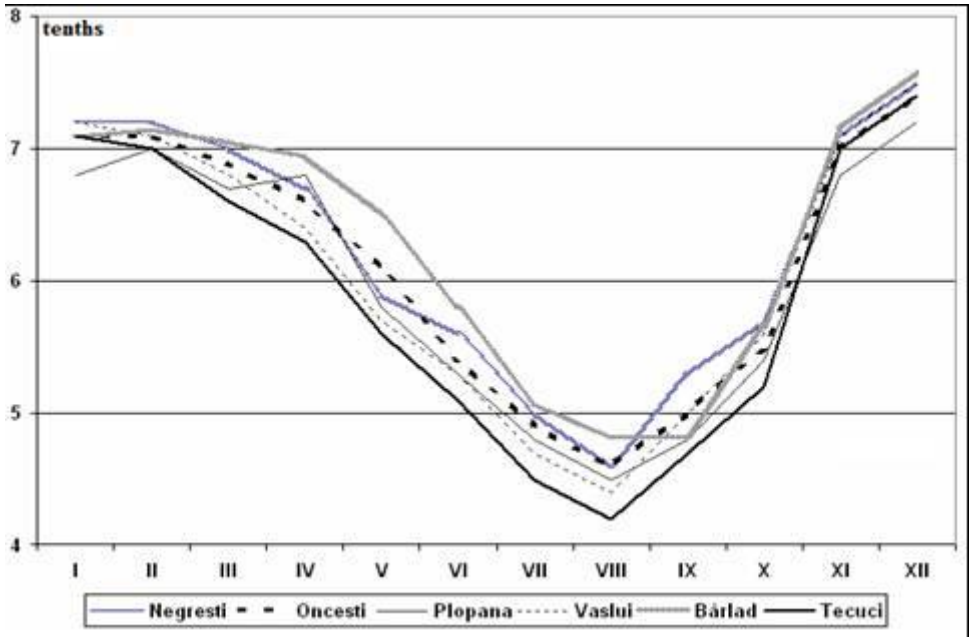

Fig. 1. The annual regime of the total nebulosity in Barlad drainage basin, Negreşti, Vaslui, Bârlad, Tecuci (1961-2010); Oncesti (1961-1999), Plopana (1964-1999).

The trend line of the nebulosity evolution from year to year shows an upward trend at 3 weather stations (Negreşti, Vaslui and Tecuci), stationary (Oncesti and Plopana) and even a downward one (Bârlad) (figure 2). The absolute values which give a positive/negative transition of these trends fluctuate around 0.3 - 0.5 tenths, that we consider to be very little, but not insignificant.

Inferior nebulosity is a parameter that exerts a more powerful influence on the other elements and climate processes than total nebulosity does. With regard to monthly and annual averages, in Barlad drainage basin, there is a strong correlation between the values of total nebulosity and those of inferior nebulosity, the latter usually has a value of 2/3 of the total nebulosity's value (table 2).

The highest annual averages in the case of total nebulosity were recorded at Barlad (6.3 tenths) and Negreşti (6.2 tenths); the values being equal at Vaslui and Oncesti (6.1 tenths). As for the inferior nebulosity it can be clearly observed the tendency of increasing values from the highest areas (Oncesti and Plopana - 3.6 tenths) towards the lower ones (Barlad - 4.4 tenths, Vaslui and Tecuci - 3.8 tenths; Negreşti - 3.7 tenths).

If, in the case of total nebulosity the average values indicated that the maximum during 24 hours was recorded in the afternoon and the morning, in that of the inferior nebulosity the highest values were recorded at most stations in the afternoon, because the thermal convection is most active at this time of the day (table 2).

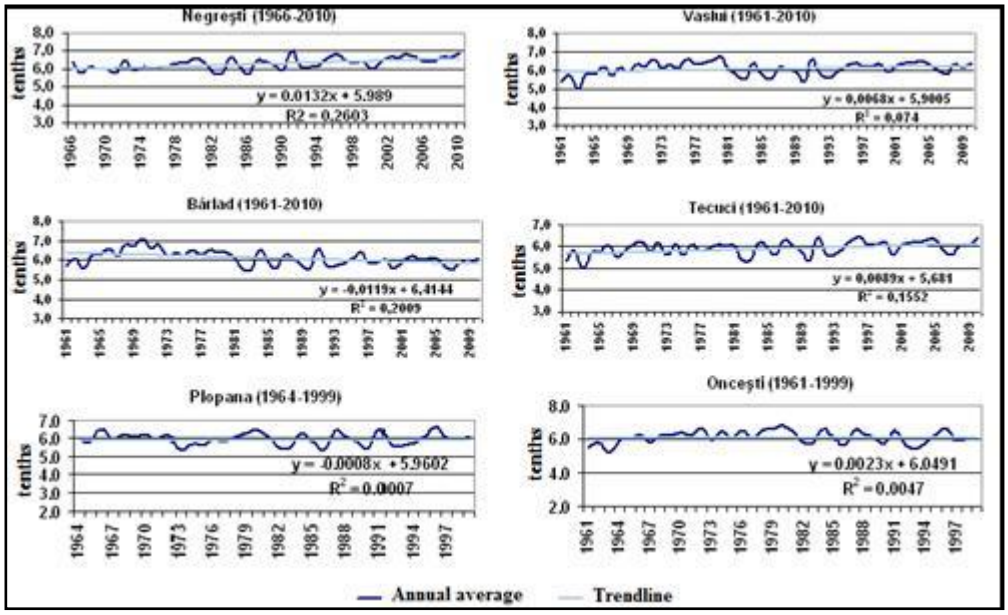

Fig. 2 The variation of the total nebulosity (tenths) from year to year at the weather stations from Barlad drainage basin. (1961-2010)

Table 2. The annual and monthly averages (tenths) of the inferior nebulosity.

Negreşti(1966-2010)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	4,9	4,6	4,0	3,1	2,2	2,2	1,9	1,6	2,0	2,8	4,6	5,3	**3,3**
7	5,6	5,5	4,9	3,7	2,8	2,6	2,1	2,1	2,9	4,4	5,7	5,9	**4,0**
13	4,7	4,4	4,4	4,4	4,1	4,5	4,1	3,5	3,4	3,4	4,8	5,1	**4,2**
19	4,5	4,1	3,8	3,5	2,8	2,8	2,5	2,2	2,5	2,6	4,3	4,8	**3,4**
Average	**4,9**	**4,6**	**4,3**	**3,7**	**3,0**	**3,0**	2,7	2,3	2,7	3,3	4,8	5,3	**3,7**

Plopana(1964-1999)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	4,8	4,5	4,0	2,8	2,3	2,1	2,0	1,7	2,0	2,8	4,5	5,1	**3,2**
7	5,0	5,2	4,6	3,5	2,8	2,5	2,0	2,0	2,7	3,9	5,2	5,4	**3,7**
13	4,5	4,4	4,4	4,3	4,1	4,1	3,9	3,2	3,3	3,4	4,7	4,7	**4,1**
19	4,2	4,1	3,7	3,2	2,6	2,6	2,3	2,2	2,2	2,5	4,3	4,7	**3,2**
Average	**4.6**	**4.6**	**4.2**	**3.5**	**3.0**	**2.8**	**2.6**	**2.3**	**2.6**	**3.2**	**4.7**	**5.0**	**3.6**

Vaslui(1961-2010)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	5,4	5,0	4,2	3,0	2,4	2,1	1,8	1,7	2,3	3,2	5,1	5,7	**3,5**
7	5,9	5,4	4,7	3,5	2,8	2,5	2,3	2,3	3,2	4,5	5,9	6,1	**4,1**
13	4,5	4,3	4,3	4,2	4,0	4,0	3,8	3,3	3,3	3,5	4,9	4,8	**4,1**
19	4,7	4,2	3,7	3,2	2,7	2,6	2,3	2,1	2,4	2,7	4,6	5,0	**3,4**
Average	**5,1**	**4,7**	**4,2**	**3,5**	**3,0**	**2,8**	**2,5**	**2,3**	**2,8**	**3,5**	**5,1**	**5,4**	**3,8**

Table 2 (continuation). The annual and monthly averages (tenths) of the inferior nebulosity.

Onceşti(1961-1999)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	4,9	4,9	4,1	2,9	2,4	2,1	1,6	1,5	1,8	2,8	4,5	5,1	**3,2**
7	5,6	5,6	4,8	3,4	2,8	2,4	2,1	2,0	2,6	4,1	5,5	5,6	**3,9**
13	4,3	4,4	4,3	4,2	4,1	4,1	3,8	3,4	3,1	3,2	4,6	4,7	**4,0**
19	4,4	4,4	3,8	3,4	2,8	2,5	2,1	2,0	2,2	2,5	4,3	4,8	**3,2**
Average	**4.8**	**4.8**	**4.2**	**3.5**	**3.0**	**2.9**	**2.4**	**2.2**	**2.4**	**3.1**	**4.7**	**5.0**	**3.6**

Bârlad (1961-2010)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	5,4	5,4	4,7	3,7	3,1	2,7	2,3	2,3	2,5	3,2	5,1	6,0	**3,9**
7	6,0	5,9	5,3	4,3	3,6	3,0	2,9	2,9	3,2	4,7	6,2	6,5	**4,5**
13	5,4	5,2	5,3	5,1	5,2	5,4	4,9	4,5	3,9	3,9	5,6	5,7	**5,0**
19	5,1	5,3	4,4	4,4	4,0	4,0	3,2	3,1	2,8	3,0	5,0	5,5	**4,2**
Average	**5,5**	**5,5**	**4,9**	**4,4**	**4,0**	**3,8**	**3,3**	**3,2**	**3,1**	**3,7**	**5,5**	**5,9**	**4,4**

Tecuci (1961-2010)

Hour	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	5,2	4,9	4,0	3,0	2,5	2,2	1,9	1,9	2,1	3,0	4,9	5,6	**3,4**
7	5,7	5,4	4,5	3,3	2,8	2,3	2,0	2,1	2,8	4,0	5,7	6,0	**3,9**
13	4,8	4,5	4,4	4,4	4,5	4,5	4,1	3,4	3,4	3,3	4,9	5,0	**4,3**
19	4,8	4,1	3,9	3,6	3,4	3,3	2,9	2,8	2,7	2,6	4,4	4,9	**3,6**
Average	**5,1**	**4,7**	**4,2**	**3,6**	**3,3**	**3,1**	**2,7**	**2,6**	**2,7**	**3,2**	**5,0**	**5,4**	**3,8**

Regarding the hourly evolution of the inferior nebulosity one can observe an upward trend present from August until December at the hours 1, 7 and 19 o'clock and from October until December at 13 o'clock, and a downward trend from December until August at the 1, 7 and 19 o'clock respectively from December until October at 13 o'clock (figure 3).

Throughout the year, the average values recorded at the hours of climatological observations have similar characteristics across Barlad drainage basin. The minimum values of the night and morning occur in July and August and of the noontime in August, September and October (figure 3).

Despite the variability and the high degree of subjectivity caused by the visual observation, without instruments, of the types of clouds, the observations made and processed (table 3) allows us to draw some conclusions. By summarizing the monthly frequencies for each pair of cloud type, the average monthly frequencies were determined, on which graphs were drawn in figure 4.

The category of clouds Stratocumulus and Stratus shows a decreasing trend from the lowland meadows of the basin towards the higher grounds. In terms of frequency during the year, this pair of clouds have the highest frequency in the cold season, from November to March, the maximum being reached in December at all weather stations in the basin, in this time of low temperatures, the inversions with fixed stratification of the air masses, favoring their genesis.

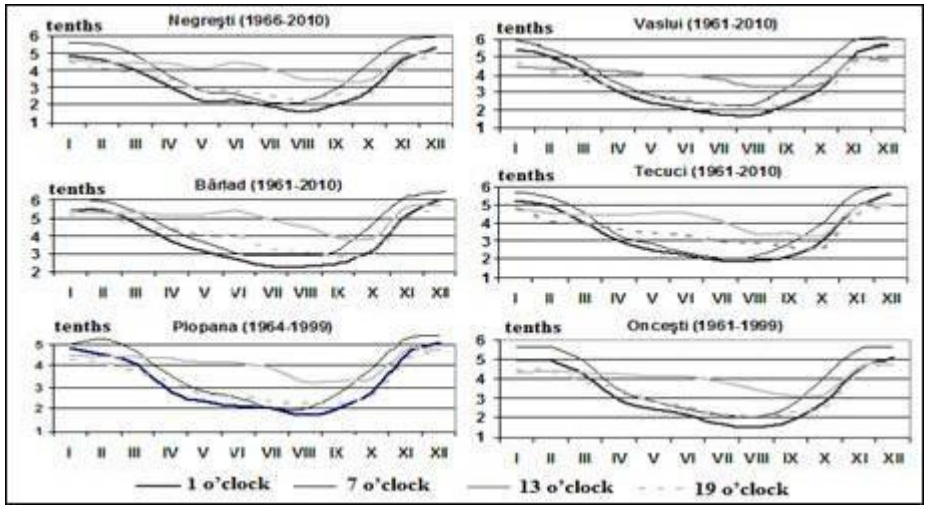

Fig. 3. The annual regime of the inferior nebulosity recorded at the hours of climatological observations. Negreşti, Vaslui, Bârlad, Tecuci (1961-2010); Oncesti (1961-1999), Plopana (1964-1999)

Table 3. The frequency (number of cases) of the main types of clouds in Barlad drainage basin

* Negreşti(1966-2000); * Plopana(1964-1999); * Onceşti (1961-1999)

Station	*Types of clouds*	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*	*XII*	*Total of year*
*Negreşti**	*As-Ns*	42,7	48,5	49,4	51,3	42,9	39,1	35,4	33,0	37,1	40,9	42,8	49,2	***512.3***
	Sc-St	61,7	51,9	55,5	46,3	35,9	29,5	27,1	26,5	34,3	48,3	60,3	68,0	***545.3***
	Cu-Cb	2,3	4,3	10,1	22,5	34,5	44,7	43,2	33,6	20,8	10,1	5,1	2,5	***233.7***
*Plopana**	*As-Ns*	47,1	48,9	52,2	57,8	49,4	41,9	37,5	35,4	37,3	40,4	45,5	49,4	***542.8***
	Sc-St	54,4	44,6	51,1	40,0	34,8	29,1	28,9	29,1	32,4	44,3	55,5	60,3	***504.5***
	Cu-Cb	2,7	4,5	9,2	20,8	29,8	37,8	36,8	30,4	18,7	9,8	5,0	2,5	***208.0***
Vaslui	*As-Ns*	38,7	40,1	42,8	44,9	37,4	34,1	29,5	25,8	28,1	30,7	34,2	39,1	***425.4***
	Sc-St	61,5	50,7	52,7	42,3	34,3	27,4	26,9	27,0	34,6	49,4	62,4	68,6	***537.8***
	Cu-Cb	2,1	5,0	11,7	23,4	36,4	43,1	42,3	33,5	21,3	10,9	5,1	2,7	***237.5***
*Onceşti**	*As-Ns*	41,2	41,2	45,6	47,0	41,8	36,2	33,2	27,9	29,7	33,7	37,9	40,3	***455.7***
	Sc-St	49,2	43,7	48,1	39,8	34,9	28,3	27,5	26,3	30,8	42,1	53,8	56,8	***481.3***
	Cu-Cb	1,7	2,6	6,6	15,4	25,7	33,4	30,7	25,2	14,3	6,5	2,4	1,3	***165.8***
Bârlad	*As-Ns*	43,5	42,7	45,8	44,0	37,1	29,1	24,8	22,6	28,3	33,1	39,9	45,3	***436.2***
	Sc-St	63,8	54,7	58,8	49,4	42,9	35,8	34,8	34,3	41,3	52,2	65,5	69,9	***603.4***
	Cu-Cb	3,8	5,9	11,3	23,7	37,9	48,4	47,0	36,3	21,7	10,4	4,2	3,8	***254.4***
Tecuci	*As-Ns*	35,8	34,5	36,5	32,0	22,5	15,8	11,4	12,0	16,6	21,1	28,8	32,9	***299.9***
	Sc-St	54,3	44,4	48,5	41,8	39,8	33,1	31,4	31,0	34,5	42,6	55,2	61,8	***518.4***
	Cu-Cb	2,0	4,0	9,9	22,1	35,7	42,3	41,4	32,9	20,7	10,0	4,4	2,5	***227.9***

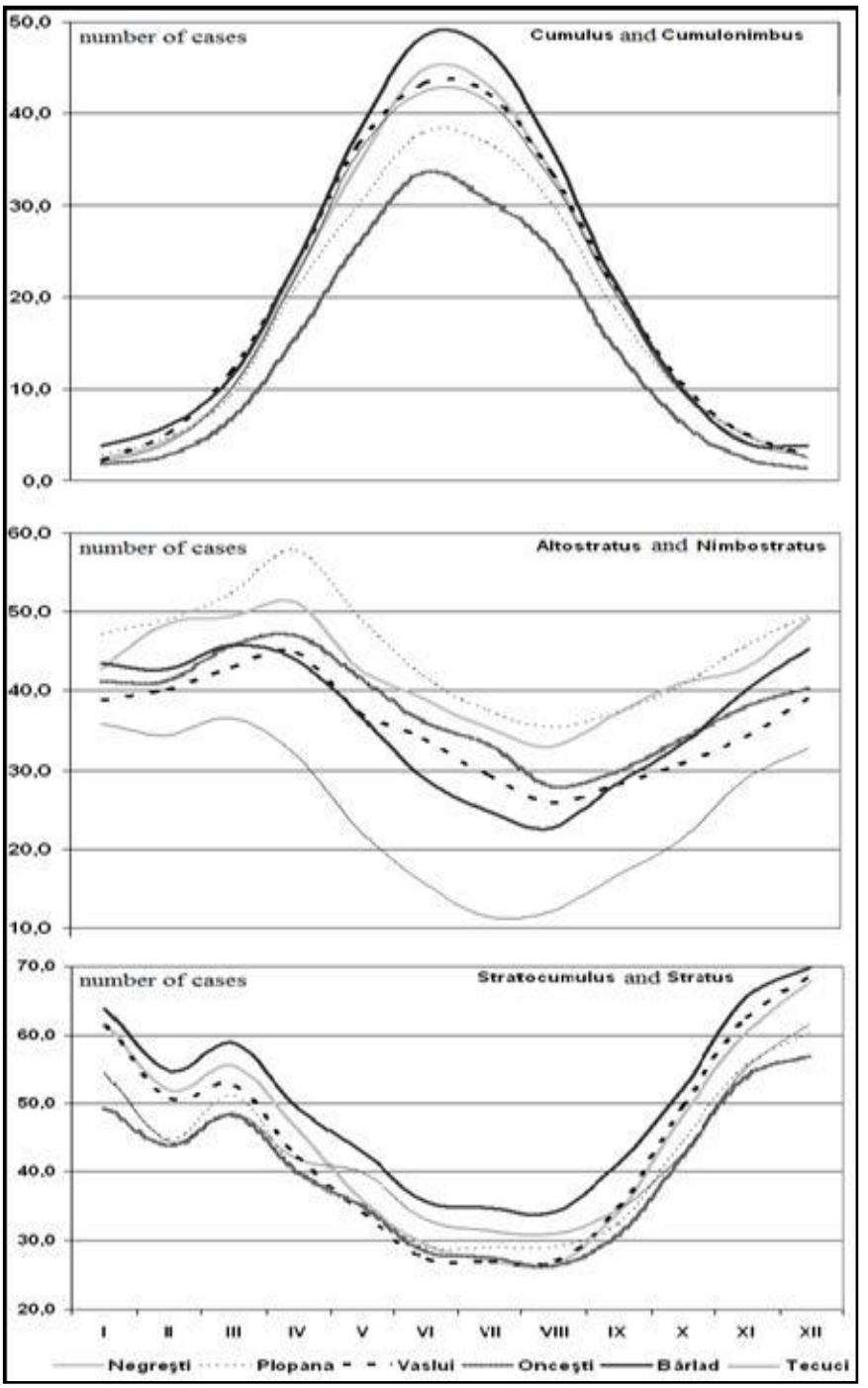

Fig 4. The variation of the monthly average (number of cases) of the main types of clouds in Barlad drainage basin: Negreşti, Vaslui, Bârlad, Tecuci (1961-2010); Oncesti (1961-1999), Plopana (1964-1999)

The highest frequency of clouds Cumulus and Cumulonimbus pair is over Bârlad river corridor, which is a lower and flatter area (from 227.9 cases/ year at Tecuci to 254.4 cases /year at Barlad) and in higher areas and hence a more uneven terrain the frequency of this clouds is much lower (from 165.8 cases / year at Oncesti to 208.0 cases / year at Plopana). This situation can be explained by the higher solarization added to the fact that the socio-economic activities conducted in the area of Barlad drainage basin are concentrated in this corridor, where all urban settlements and the main way of communication that links them are located; therefore, the dust and gas from the industrial equipment and automobiles that reach the atmosphere forms into a condensation nuclei, with an important role in the genesis of cloud systems and precipitation.

4. Conclusions

The regime of the nebulosity is determined by the influence of the atmosphere's general circulation, the local processes of moisturizing and cooling of the air, thermal stratification of the atmosphere, convective movements and other local factors. The regime of the total nebulosity over the year has maximum values in the cold season and minimum ones at the end of the summer.

The analysis of the frequency for each pair types of clouds reveals that cloud formations, such as Altostratus and Nimbostratus clouds, have the highest frequency in the high areas of the central and northern part of the basin. The highest frequency of this pair of clouds is recorded in the spring, and the lowest in the season immediately following. Annually, the category of clouds, Cumulus and Cumulonimbus, has the lowest frequency. However, due to the active thermal convection from the warm months, and very active in the summer, their frequency increases significantly.

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*** * *** *Meteorological Tables TM-1 and TM-11* for the period 1961 - 2010 from the archives of Moldova Reginal Meteorological Centre, Iaşi.