ATMOSPHERIC PRESSURE AND ITS INFLUENCE ON TOURISTS AND TOURISM ACTIVITIES IN THE PRAHOVA CORRIDOR

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ABSTRACT. Atmospheric pressure and its influence on tourists and tourism activities in the Prahova Corridor. In the climate literature it is known that the atmospheric temperature directly and permanently acts on the all organisms and all geographical environment components, influencing the wellness of the weather sensitive persons and implicitly the wellness of tourists in this region. In the same time, its evolution is a good indicator in shaping the short and medium term meteorological forecast, considering that the region chosen for research is a very tripper one, especially during the winter season when the atmospheric pressure variation trend is much more pronounced. Within this framework, the present paper tries to develop a climatic diagnosis on the reference climate parameters (annual and monthly average pressure values, seasonal values, minimum and maximum absolute values and their emergence probability but also the non-periodic variability) based on data recorded during 1961-2007 at Câmpina, Sinaia 1500, Predeal, Omu Peak and Braşov weather stations.

Keywords: Prahova Corridor, atmospheric pressure, tourism, bioclimatology.

1. INTRODUCTION

The tourism, as men outdoor activity, it is greatly dependent by the climatic condition and weather. Considering this correlation between the tourism and climatic condition and although the periodic fluctuations of the atmospheric pressure are almost unnoticeable for the human senses, and the geographical consequences are not visible (Stoenescu, 1951), it keep trace of in these paper on detail atmospheric pressure and its influence on tourists (especially on the wellness of the weather sensitive persons) and implicitly on tourism activities. Entireness of the discomfort weather generate by the atmospheric pressure reduction starting from 1500 m altitude, it is a problem that concern not only the tourists but also the tourism operators (Velcea, I., Velcea, Valeria, 2003). The greater part of the health resorts from Prahova Corridor (Sinaia, Buşteni and Azuga) is situated under 1000 m altitude. Above 1000 m altitude, there is only one health resort, Predeal, from beyond, on the highlands, under and above 2000 m altitude, there are chalets, occasionally with accommodation (Bogdan, Mic, 2011).

Teodoreanu et al. (1984) make out that the tolerant limit of decreasing oxygen its riches above 2700 meters altitude. In as far as, Romanian Carpathians highest altitude are slightly above 2500 m and exclusively in the Southern Carpathians (Omu Peak, 2504 m altitude), hypoxia inadaptability (oxygen

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decreasing from the atmosphere) is relatively minor, in such a way that it can be said that in the Romanian, climatic condition there are no restrictions regarding the touristic activities, not till certain reasons, when the oxygen rate drop under 21% (Teodoreanu, 1997; Velcea, I., Velcea, Valeria, 2003). Being known the fact that the analyzed region unfolds over a vertical deviation of 2155 m, one may assert that the *altitude*, determines the most important variations of the atmospheric pressure, and add to that the *relief form* (in the Prahova Corridor is concave) and *air temperature*. For example, the atmospheric pressure decreases with altitude because rarefaction of the air, instead, increase in negative forms of relief (valleys and depressions) due to accumulation of cold air from the slope, such as causes his increasing. In the same time, the atmospheric pressure represents an important element in the climate analysis of any region, by the role who has it in the air masses movement at local and regional level, exerting influence on the others climate elements (*Clima României*, 2008).

In this context, the present study suggests a complex approach of the baric field in an important tourism area of Romania, at regional and local level, based on the observation data from the weather stations in the region situated between 461 and 2504 m altitude, during a climate representative period (47 years).

2. DATA AND METHODS

The analysis of the pressure field was done based on the monthly and annual average data of the atmospheric pressure recorded at five weather stations situated both in the Prahova Corridor (Câmpina, Sinaia 1 500, Predeal, Omu Peak) and its surrounding region – Braşov Depression (Braşov-Ghimbav), during 1961-2007 and the values distribution mapping over the area of the atmospheric pressure annual average values (Fig. 1), was made based on the altitude correlation chart.

Thenceforth, for a better results adjustment, the data obtained for the monthly and yearly evolution of the atmospheric pressure, trends in the seasonal values (determined by the non-parametric test Mann-Kendall), but also occurrence probabilities of the yearly absolute minimum and maximum atmospheric pressure (analyzed using the Gumbel distribution function) were presented in tables format (Tables 1, 2, 3, 4).

The lowest and highest absolute values of the atmospheric pressure, and finally, the non-periodic variability of the pressure field, were synthetized in a series of suggestive charts for each weather station (Figs. 2, 3).

3. RESULTS

In our region, it can be seen that the isobars follow precisely the level curve. Thus, from ***the territorial distribution of annual averages atmospheric pressure*** (Fig. 1), results as *its values decreases with increasing altitude* from over

>950 hPa, in the sub Carpathian sector (Câmpina) and in Braşov Depression (Braşov-Ghimbav) to the values about 800 hPa, in the Carpathian sector at altitudes of 1100-1600 m (Predeal and Sinaia 1 500).

Noted that, *the lowest yearly average values* of the atmospheric pressure (<750 hPa) occur at altitudes >2500 m (Fig. 1, Table 1).

Generally, ***during the year***, the variations of the monthly averages of the atmospheric pressure are relatively low (Table 1). The weather stations placed at altitudes <1100 m (Câmpina, Predeal and Braşov) have an analogous trend of the monthly values, in that it shows a minimum spring, in *April* and a maximum fall in *October*. At altitudes above 1 500 m, monthly atmospheric pressure regime is in total contrast to the lower regions. Thus, the observational data from Sinaia 1 500 and Omu Peak, shows that the monthly values of the atmospheric pressure recorded a minimum winter, in *February* and a maximum summer, in *August* (Omu Peak) or early autumn, in *September* (Sinaia 1 500) (Table 1).

This, as in the coldest winter months, the relief depressions are enveloped in cold and dense air anticyclone, when the summer, excessive heating of the land surface contributes to the thermal expansion of the layers of air from the atmosphere based (Stoenescu, 1951).

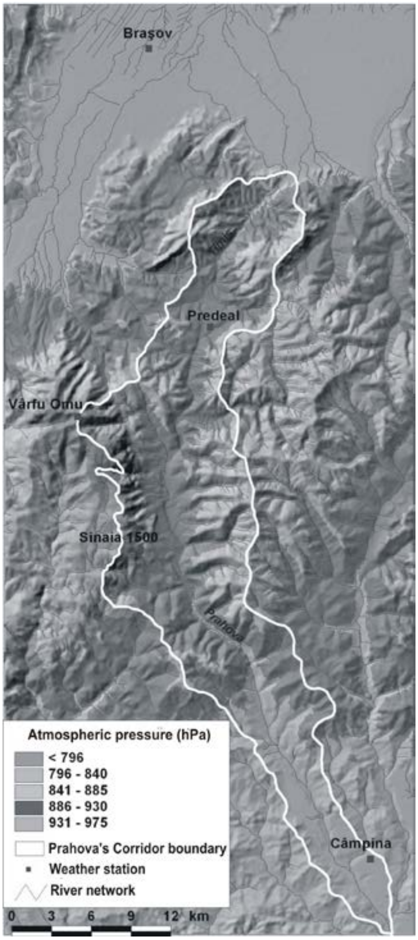

Fig. 1. The territorial distribution of annual averages atmospheric pressure

Table 1. The monthly and yearly values of the atmospheric pressure (hPa)

Weather station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yearly
Câmpina	964.1	962.5	962.1	959.6	961.3	961.3	961.6	962.5	964.3	966.1	964.2	963.6	962.8
Sinaia 1500	844.6	843.5	844.3	844.3	847.8	849.1	850.2	850.8	851.0	850.7	847.1	845.0	847.4
Predeal	890.9	889.6	889.8	888.9	891.7	892.7	893.5	894.2	894.9	895.4	892.4	891.0	892.1
Omu Peak	742.3	741.1	742.6	744.1	749.1	751.4	753.1	753.8	752.7	751.3	746.4	743.2	747.6
Braşov	955.2	953.5	952.8	950.5	952.5	952.8	953.3	954.0	955.6	957.2	955.2	954.9	953.9

* Data processed after N.M.A Archive

The seasonal values of the atmospheric pressure represent synthetical parameters which describe the annual evolution of the atmospheric pressure values on calendaristic time intervals, with applicability in various fields of activity, including tourism (*Clima RPR*, vol. I, 1962).

Over the *four seasons of the year*, *the lowest values of atmospheric pressure of* 700-800 hPa (specific to the carpathian sector) and respectively, *the highest values of* >900 hPa (specific to lowest regions), which were recorded over the 47 years analyzed, differentiated a lot from the local multiannual averages, although the Prahova Corridor and its surrounding region (Braşov Depression) are not frequently crossed by the central parts of cyclones and anticyclones, but rather by their various sectors. The analysis of the pressure field at season level highlights *a general increase trend* (Table 2), with some differentiations induced by altitudinal background[2].

Table 2. Trends in the seasonal values of the atmospheric pressure

Weather station	Winter	Spring	Summer	Autumn
	10-year variation rate (hPa/season)[1]	10-year variation rate (hPa/season)	10-year variation rate (hPa/season)	10-year variation rate (hPa/season)
Câmpina	+ 0.9 (**)	+ 0.3 (*)	+ 0.1 (-)	+ 0.0 (-)
Sinaia 1 500	+ 0.4 (-)	+ 0.0 (-)	- 0.1 (-)	- 0.5 (**)
Predeal	+ 0.8 (*)	+ 0.3 (*)	+ 0.1 (-)	- 0.1 (-)
Omu Peak	+ 1.2 (***)	+ 0.7 (***)	+ 0.6 (***)	+ 0.2 (-)
Braşov	+ 1.0 (**)	+ 0.5 (**)	+ 0.1 (-)	+ 0.0 (-)

Mann-Kendall Test (Salmi et. al., 2002)

In the winter, the atmospheric pressure trends are exclusively positive at all considered stations with the most obvious increases (>99% significance level) at altitudes >2500 m and with an increase rate of 1.2 hPa/winter (Omu Peak – *the highest seasonal value in the entire region*). At the rest of the analyzed weather stations, the trends show statistical significance (95-99%) only at altitudes <1100 m (Table 2), where the 10-year variation rate (10-year variation rate) of the atmospheric pressure ranges between +0.8 and +1.0 hPa/season. *In the Spring*, the trends maintain positive at all the five analyzed meteorological stations. Out of these, the Omu Peak, Predeal and Braşov stations show the same statistics significance as in the winter season, with increase rates between 0.3 and 0.7 hPa/season. It is noteworthy that, at Câmpina, the trend and the increase rate are identical with those at Predeal (0.3 hPa/season), and the only weather station which does not record, not even this time, any statistical significance, is the Sinaia 1500 station. *In the other two seasons* (Table 2), the atmospheric pressure tends to decrease only at Sinaia 1 500 station (in the summer) and at altitudes between 1100 and 1600 m – Predeal and Sinaia 1500 stations (in the autumn).

Also, the trends has statistical significance (99% and >99% significance level) only in the carpathian sector, at altitudes >1500 m (in the summer, at Omu Peak and in the autumn, at Sinaia 1500).

[2]*** α = 0.001 confidence level (99.99%), ** α = 0.01 confidence level (99%), * α = 0.05 confidence level (95%) confidence level; + α = 0.1 confidence level (90%); – = no statistical significance.

The unequal warming of the active surface, makes that within the same territorial sub-unit to appear ***minimum and maximum local pressure values*** which are determined by baric formations – cyclones and anticyclones, extremely strong (Mihăilă, 2006; *Clima României*, 2008). Thus, in the following, we will try to show, based on the synoptic maps, after electronic archive of the Karlsruhe Meteorological Center (www.wetterzentrale.de), which are the baric formations corresponding to ***the absolute values of the atmospheric pressure***, recorded at the weather stations in the studied area (Fig. 2).

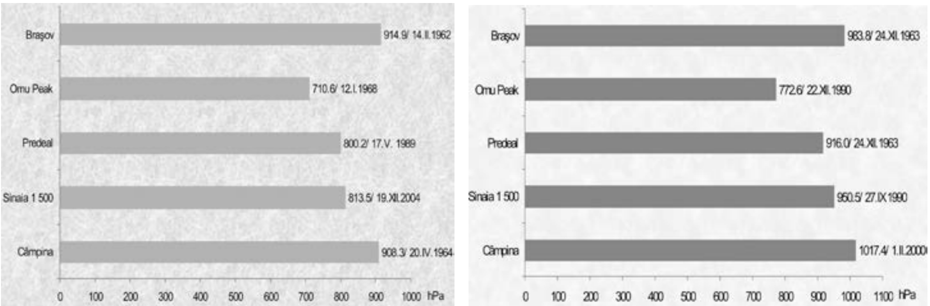

Fig. 2. Absolute minimum (left) and maximum (right) values of the atmospheric pressure

Analyzing the pressure field at the Europe level, one may assert that, in 1962, *the absolute minimum value recorded in the surrounding region of the Prahova Corridor* (914.9 hPa at Braşov, on February the 14th) was due to the formation of a depression corridor over the Western and sometimes Central Europe, between the Iceland Depression trough extended in the South and the mediteranean Cyclones active from the Southern extremity of the continent. Instead, *weather stations in the Prahova Corridor*, the baric formation corresponding *to the absolute minimum values of the atmospheric pressure* in years 1964 (908.3 hPa at Câmpina on April the 20th), 1968 (710.6 hPa at Omu Peak, on January the 12th), 1989 (800.2 hPa at Predeal, on May the 17th) and 2004 (813.5 hPa at Sinaia 1500, on December the 19th) prevailing was the one set-up by a high pressure belt formed between the ridge of the East-European Anticyclone and the Azoric Anticyclone one. *The absolute maximum values of the atmospheric pressure* recorded at Predeal (916.0 hPa) and Braşov (983.8 hPa) on December the 24th, 1963, were generated by the ridge of the East-European Anticyclone, which went alone over the Romania's territory, not being tied by the Azoric one, which maintained in the region of origin. The remaining weather stations analyzed, the absolute maximum value recorded the beginning and the end of 10th decade of the twentieth century, in 1990 at altitudes higher than 1 500 m (950.5 hPa at Sinaia 1500 on September the 27th and respectively, 772.6 hPa at Omu Peak on December the 22th) and in 2000, in the subcarpathian sector (1017.4 hPa at Câmpina on February the 1th). What is especially drawing the attention is the fact that the only weather station in the region, at which was exceeded 1015 hPa (>1017 hPa) landmark value is precisely this last weather station in the subcarpathian sector, this being the reason that year 2000 was considered a year with *an anti-cyclonicity pronounced tendency*. In fact, of previously, it fallows that in most part of the analyzed period there is a *dominant trend of the anti-cyclonic activity over reference region.* As it could be seen, the atmospheric pressure in Prahova Corridor may rise in some circumstances at high levels of strong anticyclone baric formations but can lower and lower values they register deep cyclonic baric formations, but *for short periods* (Mihăilă, 2006). *The absolute maximum values* of the atmospheric pressure in the cold season, as was the case those recorded in 1963 (Braşov and Predeal), 1990 (Omu Peak) and in 2000 (Câmpina) *create difficult situations to bear, both for the people of these regions, that suffering from heart, rheumatism or chest trouble, as well as tourists,* especially because this time of year and the air temperature is low and relative air humidity is high. Therefore, should be taken into account these issues at least in the *Predeal and Sinaia tourist resorts,* because the calculate probabilities for the absolute maximum values of the atmospheric pressure, recorded at the weather station in the region indicate *possibility of values higher than those recorded during 1961-2007* (Table 3).

Table 3. Yearly absolute maximum pressure with different occurrence probabilities

Weather station	Occurence probabilities (%)						
	1	2	5	10	20	50	100
	Return period (years)						
	100	50	20	10	5	2	1
Câmpina	1007.3	1003.5	998.5	994.7	990.9	985.9	982.1
Sinaia 1 500	971.0	955.0	934.0	918.1	902.1	881.1	865.2
Predeal	917.0	915.5	913.4	911.9	910.3	908.3	906.7
Omu Peak	770.4	769.1	767.3	766.0	764.7	763.0	761.6
Braşov	983.7	981.9	979.5	977.6	975.8	973.4	971.6

* Data processed after N.M.A Archive

The same for ***the atmospheric pressure absolute minimum values***, where ***the calculations on their probability of producing,*** highlights the occurrence probabilities of values higher than recorded, at all the five analyzed weather stations, and which may have a return period between 1 and 100 years (Table 4).

The long term variations of the atmospheric pressure are shown in Fig. 3

Table 4. Yearly absolute minimum pressure with different occurrence probabilities

Weather station	Occurence probabilities (%)						
	1	2	5	10	20	50	100
	Return period (years)						
	100	50	20	10	5	2	1
Câmpina	955.9	952.5	948.0	944.5	941.1	936.6	933.2
Sinaia 1 500	836.2	833.7	830.4	828.0	825.5	822.2	819.7
Predeal	900.2	894.3	886.5	880.6	874.7	866.9	861.0
Omu Peak	736.0	733.5	730.3	727.8	725.3	722.1	719.6
Braşov	945.5	942.5	938.5	935.5	932.5	928.5	925.4

* Data processed after N.M.A Archive

The evolution of the annual average atmospheric pressure at Câmpina weather station (Fig. 3), suggests a rather large variation, from one year to another during the first decades (1961-1981) of the analyzed period.

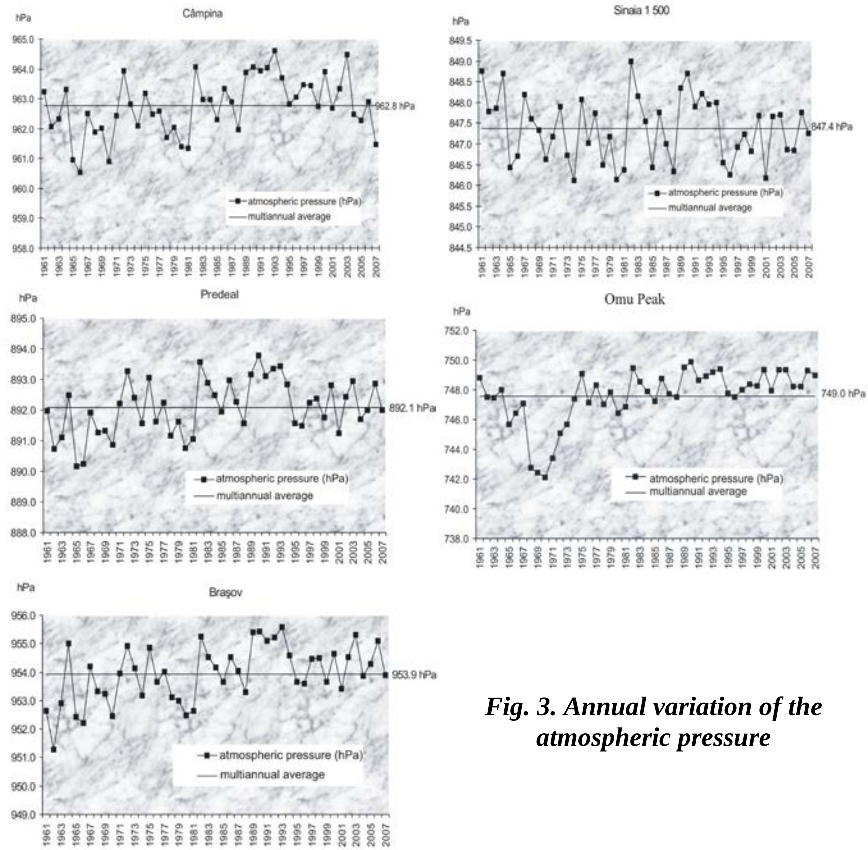

Fig. 3. Annual variation of the atmospheric pressure

After *1981*, the annual average values mark an increase which is maintained until 2007, pointing out *the intensification of average anticyclone regime*, and the last year to be characterized by low values. According to the chart, in the years 1966 and 1993 the lowest and respectively the highest annual average pressures were recorded.

The same *cyclonicity trend* is maintained at the rest of the analyzed weather stations until the year *1981* at Predeal, Sinaia 1500 and Braşov and only during the first decade of the analyzed period (1961-1970), *at altitudes >2500 m* (Omu Peak). After the years *1981 and respectively 1970*, the annual average pressure records again this time an *increase trend*, which is of *anticyclonicity*, which is maintained until the end of the analyzed period, at all four weather stations considered (Fig. 3).

From the figure above, one may note that *the years with the lowest annual average atmospheric pressures are*: 1974 at Sinaia 1 500, 1965 at Predeal, 1970 at Omu Peak and 1962 at Braşov, and the years with the highest values: 1982 at Sinaia 1500, Predeal and Braşov and 1990 at Omu Peak.

4. CONCLUSIONS

Based on the above, we may shape several considerations as conclusions: 1). Knowledge of the pressure field condition from an important Romanian resort, such as Prahova Corridor, it give besides the explanation of the local and general atmospheric circulation, a range of weather condition foresight; 2). For the climate of hills and mountains less than 1500 meters high, monthly variations of the atmospheric pressure are relatively low, practical there are no contraindication for the people who wants to travel in the touristic resorts. Instead, with the altitude growth, the conditions are getting rough, harder bio climate, various acclimatization according to altitude, disease, age, etc. (Teodoreanu, 1997); 3). During 1961-2007, the seasonal values of the atmospheric pressure described a general increasing trend, more evident for Omu Peak (winter, spring and summertime) reflecting quite accurately the weather conditions from altitude above 2500 meters and the specific atmospheric fluctuations; 4). Absolute minimum and maximum values of the pressure field occurring on shorts periods and unexpected pressure variation; can provide unpleasant effects for the wellness of the weather sensitive persons; 5). Conclude, considering that in Romanian climate conditions, implicitly in the Prahova Corridor, cannot take into consideration the hypoxic stress or altitude sickness caused by the rarefied air, therefore in this region are no restrictions for touristic activities.

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