Preliminary results obtained following the intercomparison of the meteorological parameters provided by automatic and classical stations in Romania

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Abstract

At present, 60 automatic weather stations operate in the Romanian meteorological network, two of which - of THIES CLIMA type and the rest – VAISALA (MAWS301 and MILOS). In order to compare and analyse the meteorological parameters provided by the automatic and classical stations, parallel measurements were performed at 18 weather stations, uniformly distributed over the Romanian territory.

There were analysed the hourly values of the following parameters, recorded in 2004: mean temperature, minimum and maximum air temperature, relative humidity and air pressure, from the considered stations.

The statistical parameters computed for the air temperature components showed that the mean daily values recorded by the automatic station does not differ significantly from those obtained with classical instruments, whereas the extreme values – the daily minimum and maximum – differ significantly from the statistical standpoint.

The statistical parameters were also computed of the differences between data yielded through the two measuring methods (classical and automatic), for relative humidity and air pressure.

Data yielded from measurements carried out with various technical systems disclose small differences for one identical geographic environment. However, in view to analyse climate changes, it is important to compare obtained results. The factors that may intervene in the analysis of long term climate changes, resulting from the change of the "conventional" measurement system to the automated one, refer to changes in: observation terms, mediation methods, station location, apparatus design, calibration methods. Differences may be systematic or stochastic. Long-term intercomparison (1-2 years) is necessary of the two systems, in representative locations and in varied meteorological conditions, in order to test the compatibility of the two systems and establish correction algorithms.

To write this paper, there were used hourly precipitation, air pressure and humidity data, as well as extreme temperature data, recorded in parallel, in the January-September 2004 interval, at the automatic and classical stations. Inter-comparative measurements took place at 18 weather stations endowed with MAWS 301 automatic stations (except for Bucharest Baneasa, where the automatic station is a THIES one and Buzau - endowed with portable MAWS one). Stations were chosen observing the principle of major climatic areas representative features. Table 1 renders classical interests and the sensors type of MAWS 301 automatic stations for each meteorological element to be used in the intercomparison.

Table 1

Measured parameter	Classical instruments	Instrument location	MAWS 301 sensors	Sensor location
Air temperature	Mercury thermometer	In instrument screen, 2m above ground	QMH101	On station arm, 2m above ground
Air minimum temperature	Alcohol thermometer	In instrument screen, 2m above ground	QMH101	On station arm, 2m above ground
Air maximum temperature	Mercury thermometer	In instrument screen, 2m above ground	QMH101	On station arm, 2m above ground
Relative humidity	Hair hygrometer	In instrument screen, 2m above ground	QMH101	On station arm, 2m above ground
Air pressure	Mercury barometer	In station office	PMT16A	In station logger

To highlight differentiation between the two observation types and recording errors of classical and even automatic ones, comparative graphs were drawn for each parameter, day or station taken apart. Figures 1 to 5 exemplify the evolution of the hourly values of the five analysed parameters, recorded classically and automatically.

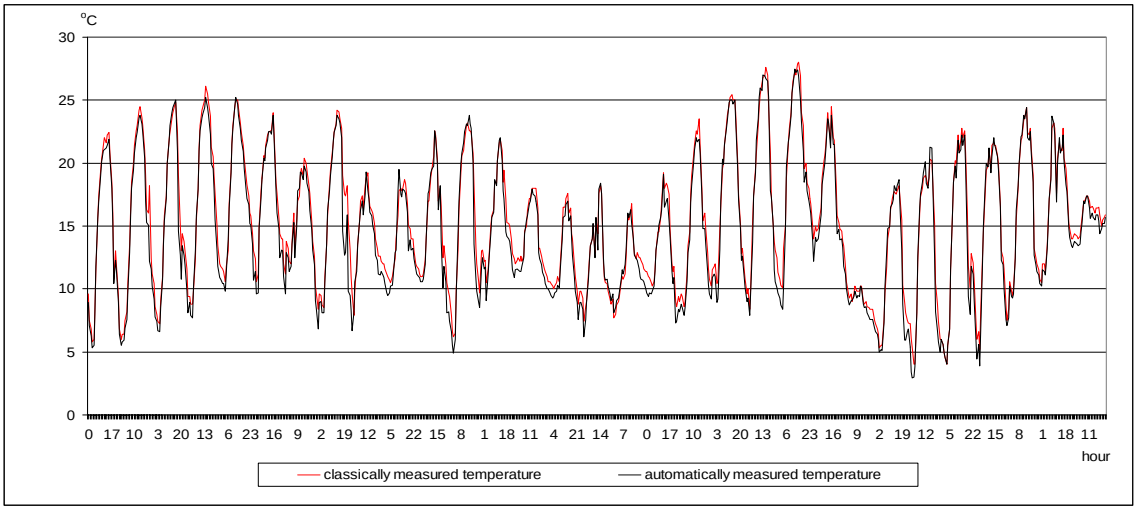

Fig. 1 Hourly variation of air temperature (°C) at Bucharest-Baneasa weather station in May 2004

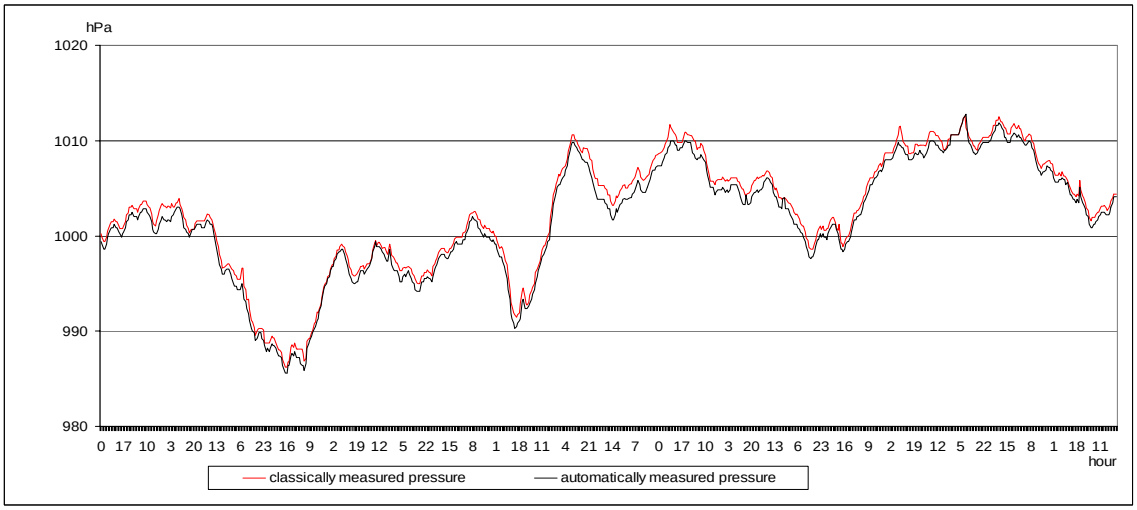

Fig. 2 Hourly variation of air pressure (hPa) at Bucharest-Baneasa weather station in May 2004

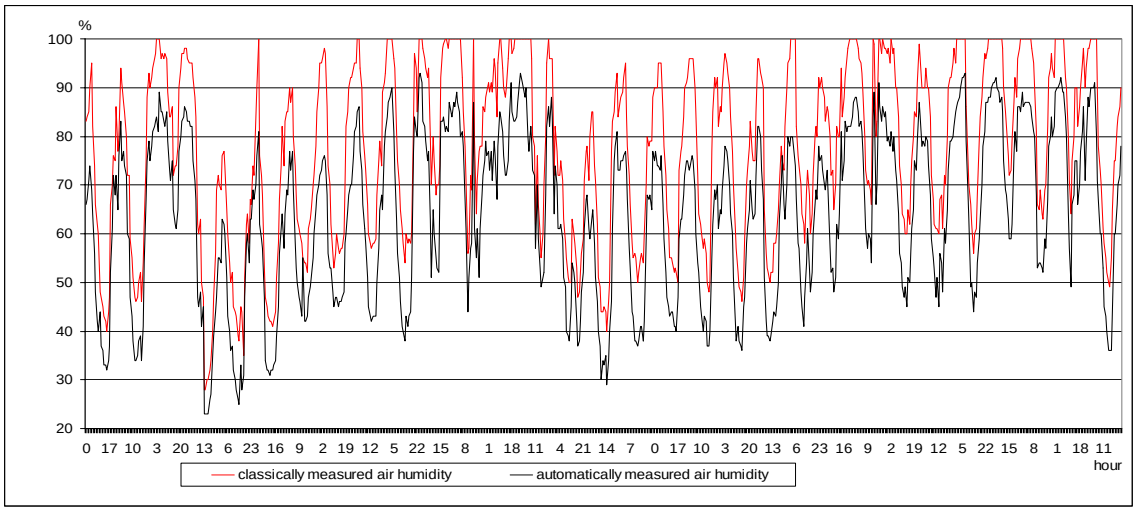

Fig. 3 Hourly variation of air humidity (%) at Buzau weather station in July 2004

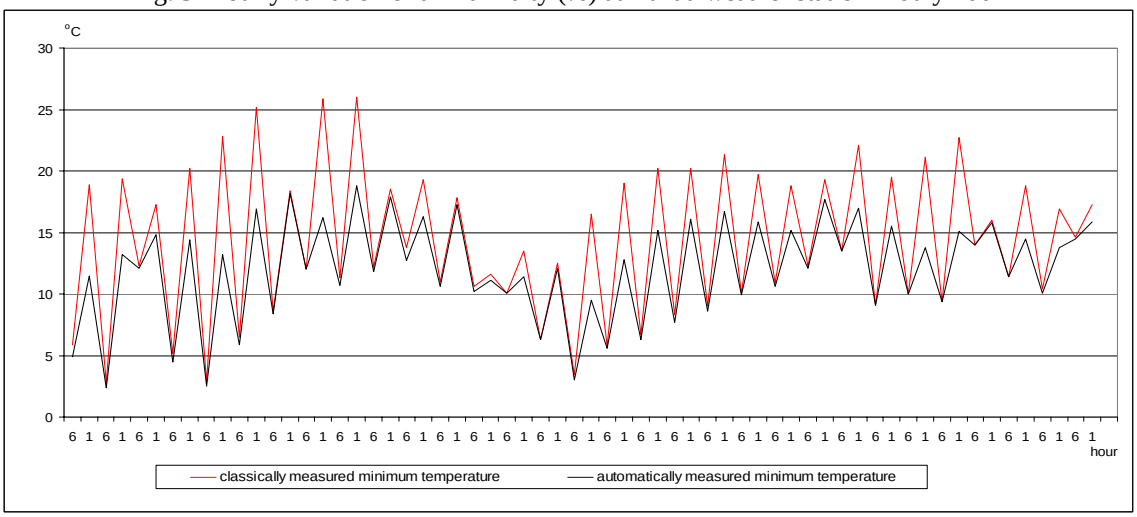

Fig. 4 Hourly variation of minimum air temperature (^{o}C) at Miercurea Ciuc weather station in July 2004

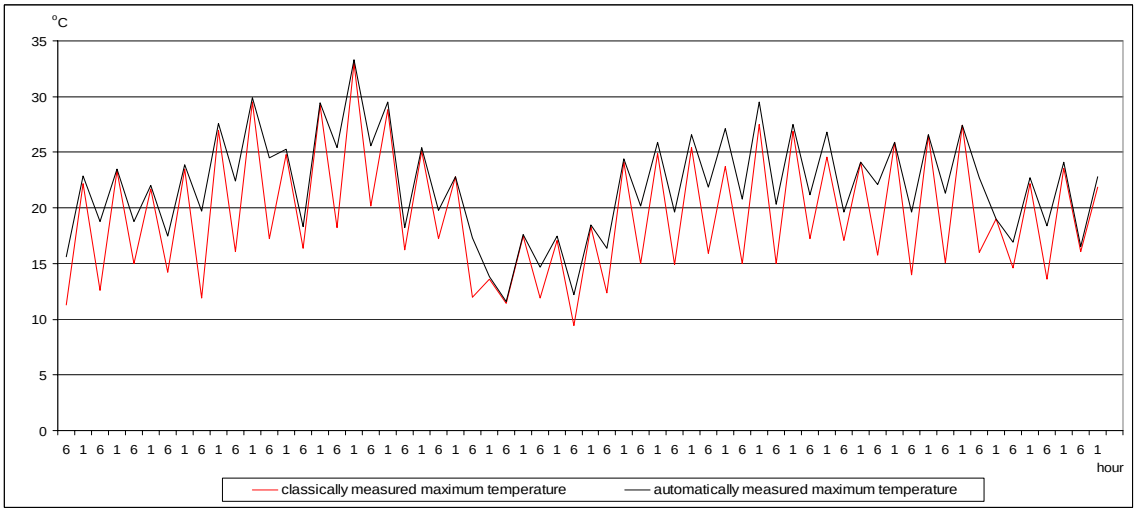

Fig. 5 Hourly variation of maximum air temperature (^{o}C) at Miercurea Ciuc weather station in July 2004

There were also computed: the mean of the hourly data series, the mean square deviation and the correlation coefficient, whereas for the residue series (differences between classical and automatic measurement), the mean, mean square deviation and amplitude of these series were computed. In figures 6 to 15 the monthly means are rendered of the residue series for each parameter, i.e. the amplitude of these series.

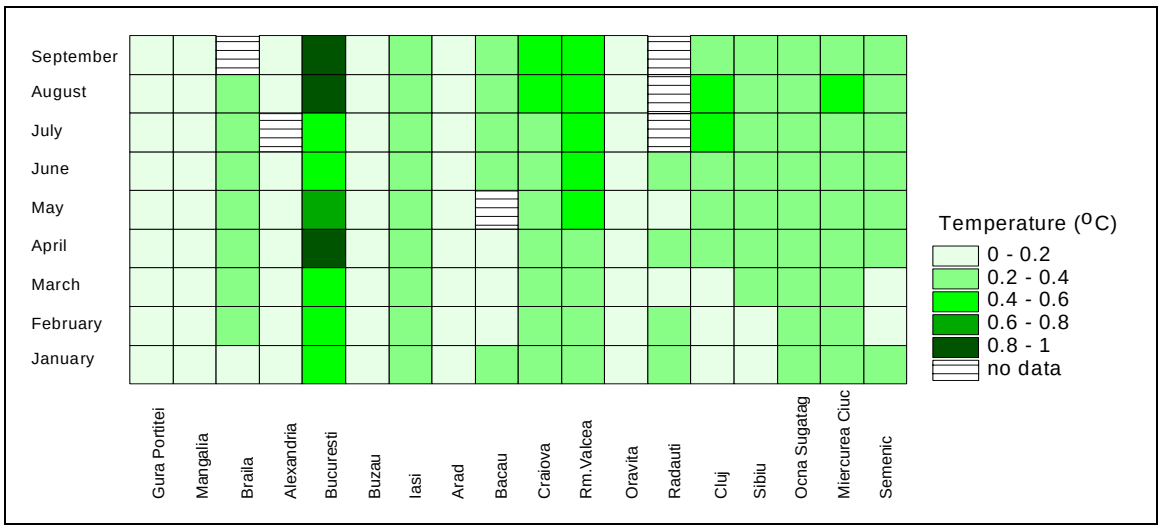

Fig. 6 – Monthly mean of differences between the classically and automatically measured hourly mean temperature

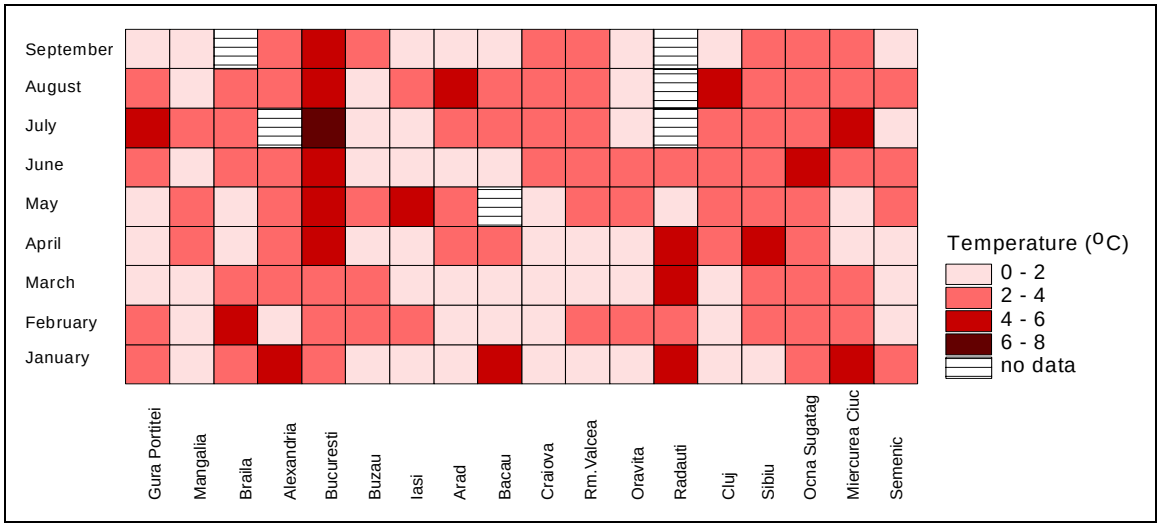

Fig. 7 Amplitude of difference series between classically and automatically measured hourly mean temperatures

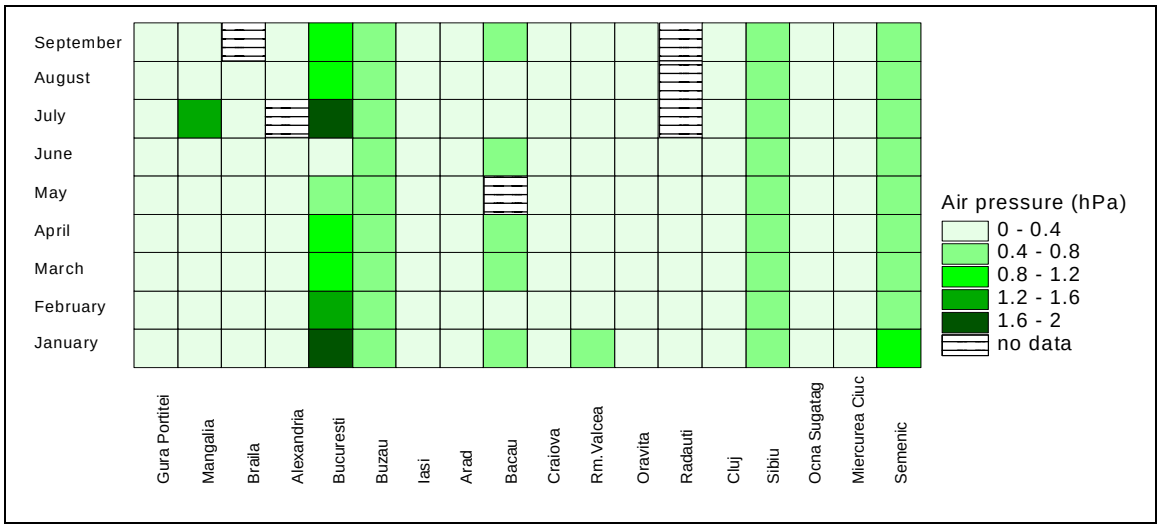

Fig. 8 Monthly mean of differences between classically and automatically measured air pressure

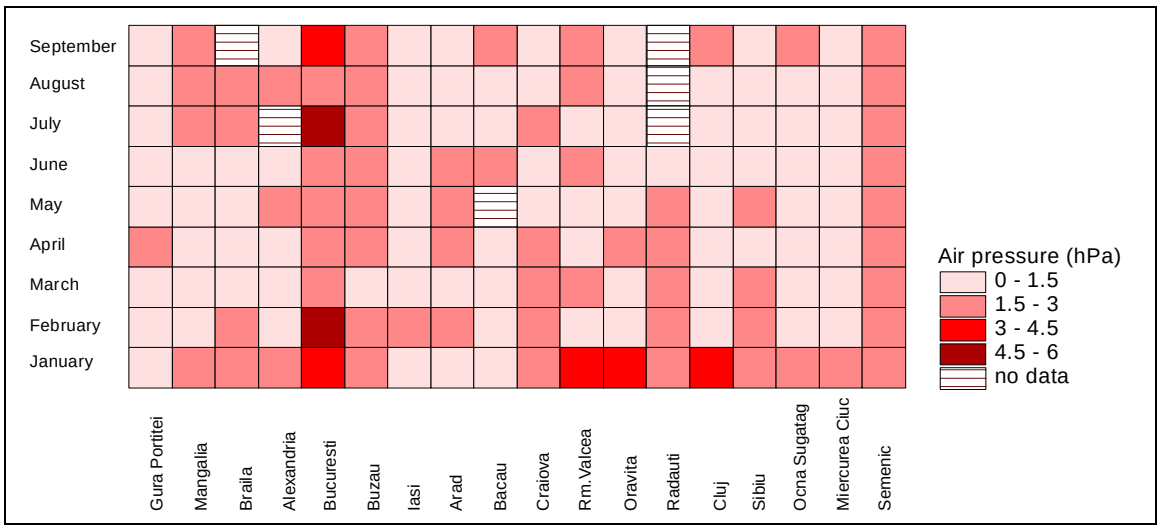

Fig. 9 Amplitude of difference series between classically and automatically measured air pressure

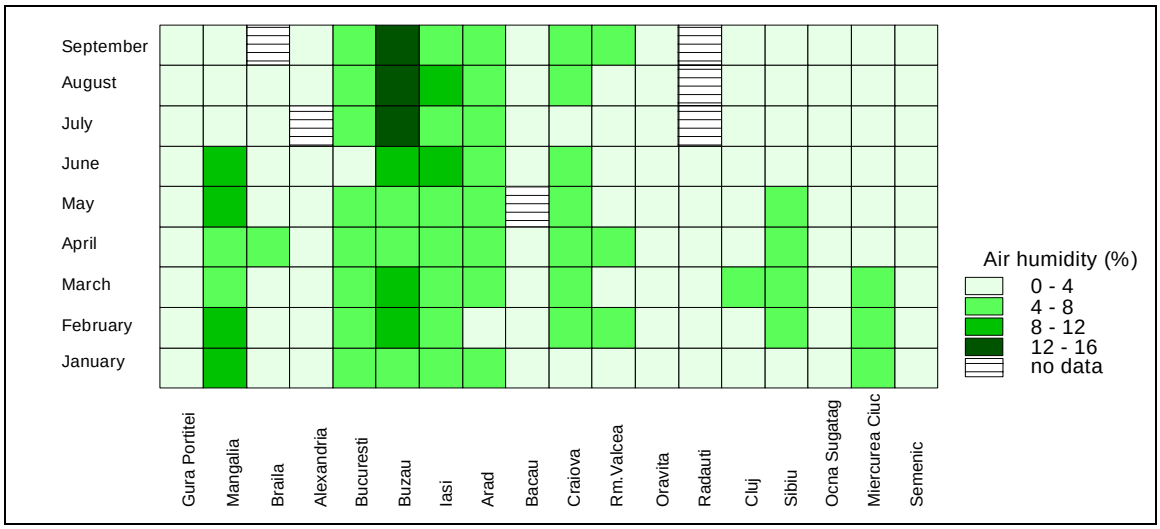

Fig. 10 Monthly mean of differences between classically and automatically measured relative humidity

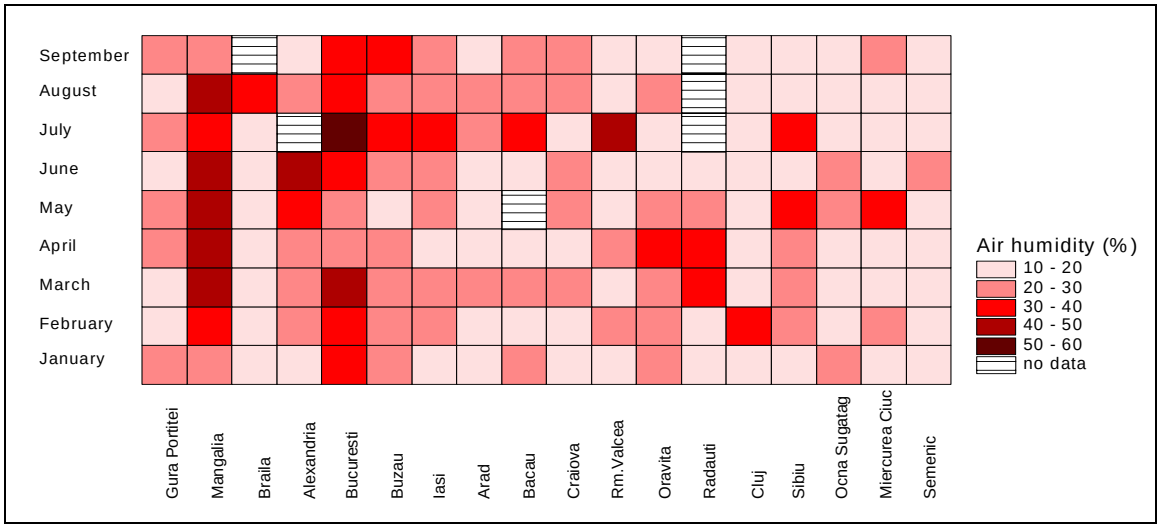

Fig. 11 Amplitude of difference series between classically and automatically measured relative humidity

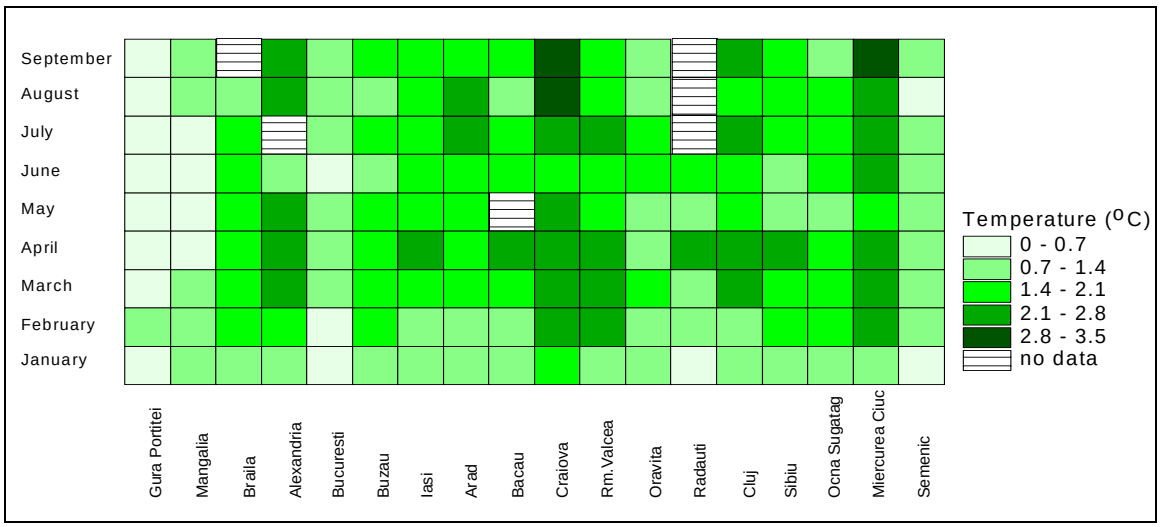

Fig. 12 Monthly mean of differences between classically and automatically measured minimum air temperature

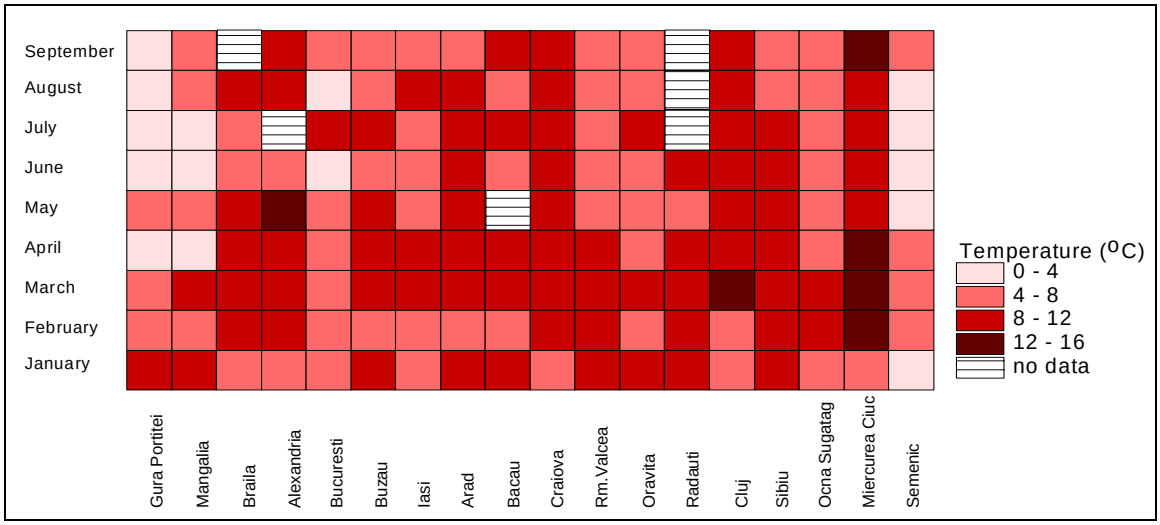

Fig. 13 – Amplitude of difference series between classically and automatically measured minimum air temperature

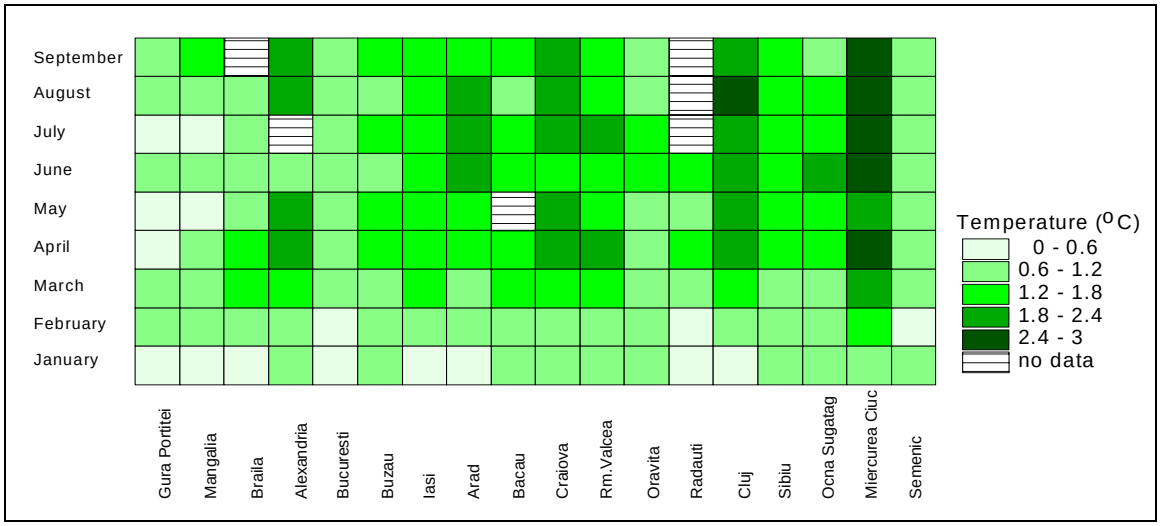

Fig. 14 – Monthly mean of differences between classically and automatically measured maximum temperature

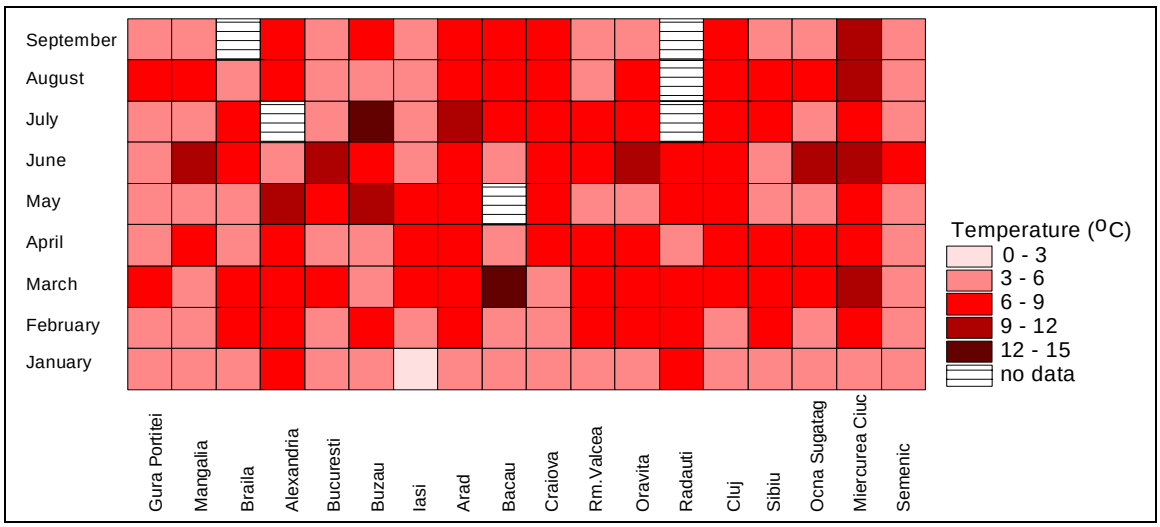

Fig. 15 Amplitude of difference series between classically and automatically measured maximum air temperature

Another statistical analysis was performed through applying the averages Student test, to check the existence of any significant difference between the values in the two series. We mention that t value in the tables is 1.96 for mean temperature, humidity and air pressure and 1.94 for extreme temperatures, both showing a confidence level of 95%. Student test results are rendered in figs 16-19.

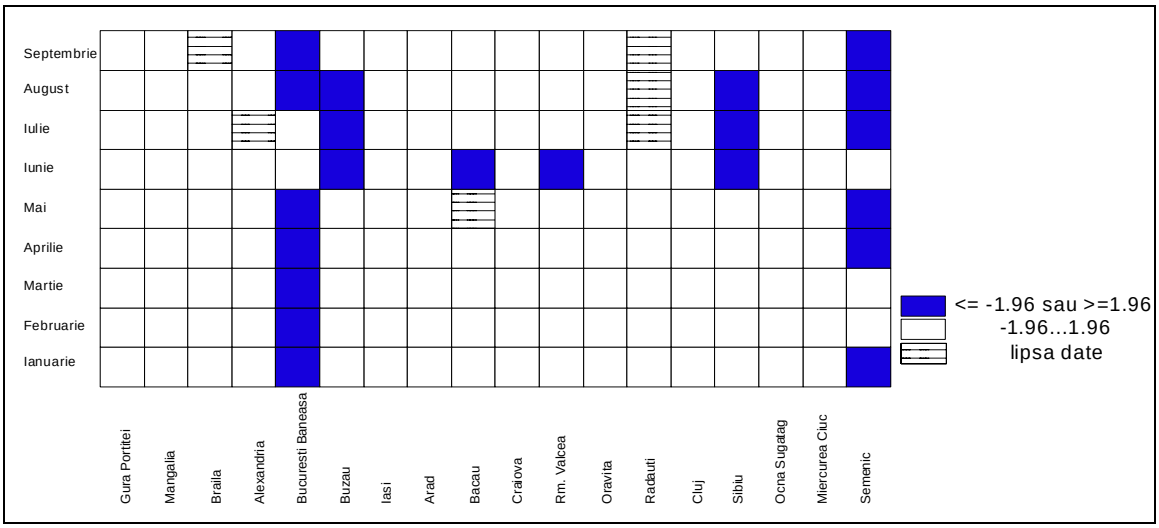

Fig. 16 Student test results for air pressure

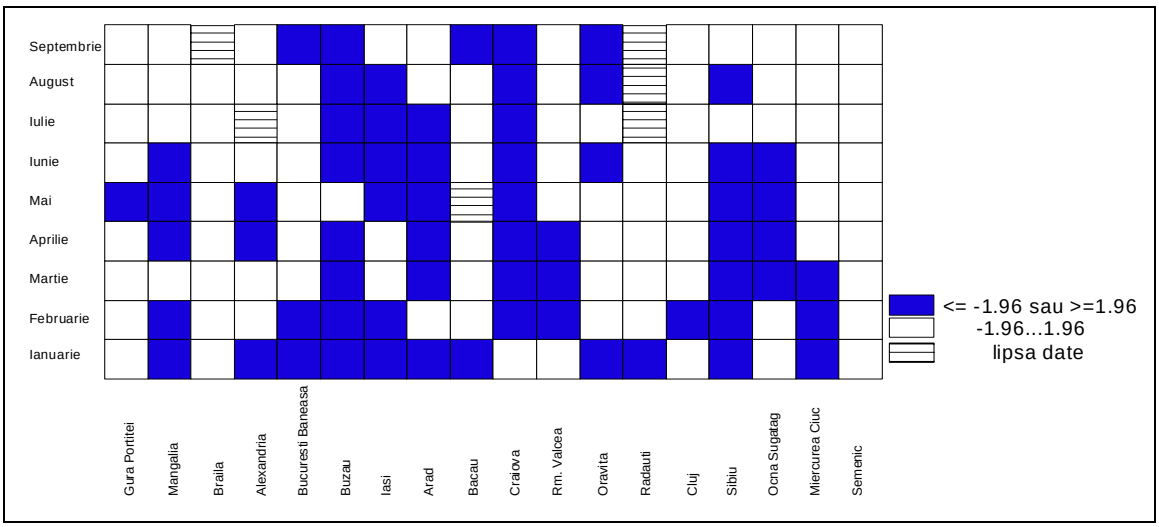

Fig. 17 Student test results for relative humidity

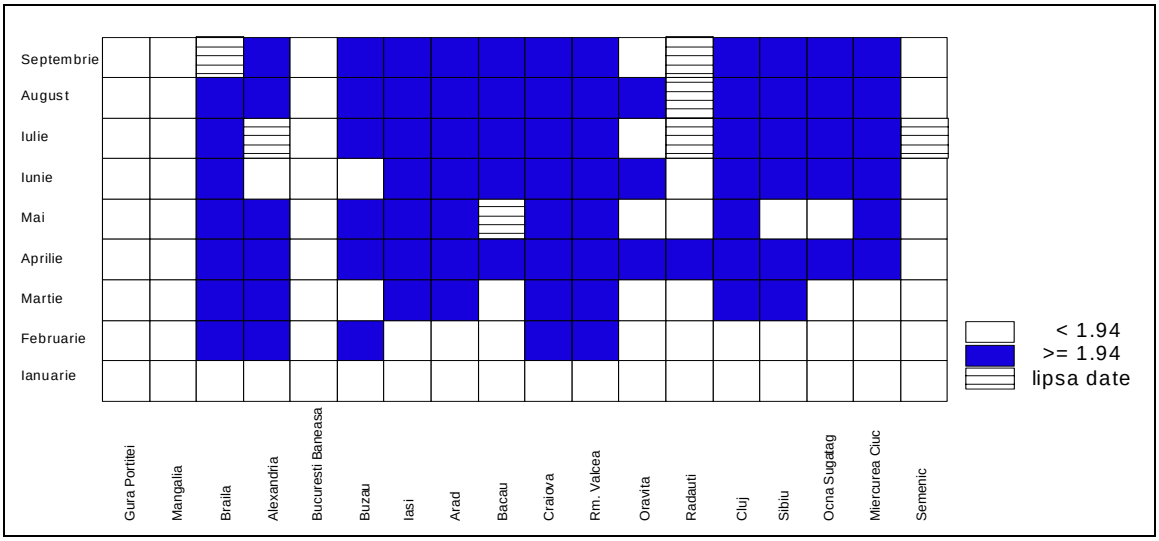

Fig. 18 Student test results for minimum temperature

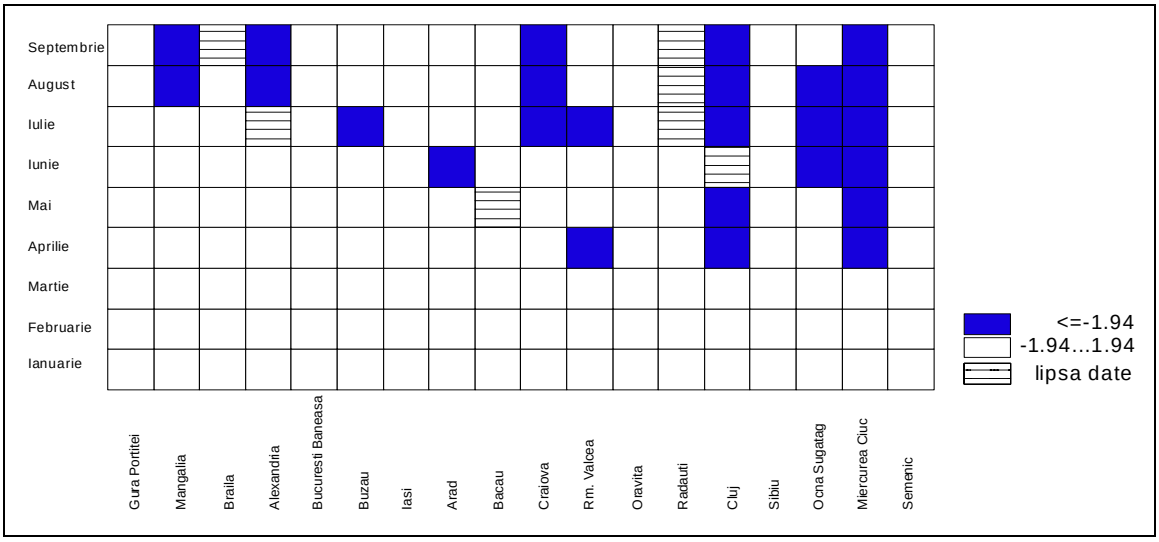

Fig. 19 Student test results for maximum temperature

The mean air temperature does not display large differences between the two series measured classically and automatically. The monthly means of the differences between the mean hourly temperature measured at the classical station and the temperature measured by the automatic one kept within 0 – 0.6°C at all analysed stations, except for Bucharest Baneasa, where the mean is higher than elsewhere, namely between 0.6 and 1°C (fig. 6). Student test results also show that the difference of the mean temperature values is significant (not accidental), with a confidence level of 95%, again at Bucharest Baneasa, in April, May, August and September. We mention that Bucharest Baneasa weather station is a THIES one, different from the other 17 MAWS - type that made measurements.

As a rule, the air pressure did not record very large differences between the classical and the automatic stations, the mean of the differences series ranging within 0-0.8 hPa in all the months. Bucharest Baneasa stands out again, with values of the differences mean reaching 2 hPa (fig. 8). Student test disclosed that at Bucharest Baneasa, Buzau, Bacau, Rm. Valcea, Sibiu and Semenic stations differences between classical and automatic measurements are significant as regards one or more months. It is remarkable that values recorded with the classical station are higher than those

recorded automatically keeping a constant difference throughout one whole month. Given the constant character with time of the monthly means of the differences between the two types of measurements at five of the 18 stations, this suggest either one apparatus failure or wrong application of temperature corrections.

The relative moisture is characterized through very large amplitudes of the series of differences between the classical and the automatic measurements, ranging from 10 to 52 % (fig. 10). Student test results (fig. 17) also prove that differences between classical and automatic measurements are significant at a quite large number of stations, with January and February standing out. Differences between the two types of measurements may be attributed to the different measurement environments (instrument screens with different inertia), to the hygrometer sensitiveness and to the variation of its indications against temperature evolution. However, the relatively small variations of the mean temperatures cannot account for the large humidity variations. As a conclusion this issue remains to be studied and hygrometers may be to recalibrate in standard conditions (climatic chambers).

Extreme temperatures have a common feature: values recorded classically are always higher for the minimum temperature (fig. 4) and lower for the maximum one (fig. 5) than those recorded automatically, most remarkable at 18.00 p.m. At all stations and almost throughout the whole period, the monthly means of the series of differences between classical and automatic measurements range from 1.4 to 3.5°C as regards the minimum temperature (fig. 12) and from 1.2 to 3.0°C as regards the maximum temperature (fig. 14). The amplitude of the differences of the minimum temperatures reaches 15.7°C (March, Miercurea Ciuc), whereas that of the series of differences of the maximum temperatures reaches 14.3°C (March, Bacau).

The significant differences between the extreme temperatures are the natural consequence of the difference in the measurement environment and implicitly of the different inertia of the instrument screens.