Telemetric Systems and the Assessment of the Air Quality in the City Area

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Abstract: In this paper, the air quality network that will be analyzed are the Bucharest Network, which provide the real time data on current level of air pollution in representative high-traffic, residential, industrial and urban-background locations in Bucharest and produce information to determine the origin of pollutants within the designated areas (source receptor relationships based on air quality and meteorological data). The Bucharest air quality monitoring network has 8 stations (2 traffic stations, 3 industrial stations, 1 urban background stations, 1 regional background stations and 1 suburban background stations). For this paper the particulate matter (PM10) was investigated at the traffic stations. The results of the study show the concentrations of aerosol are due to natural and anthropogenic local sources, but also to long-range transport of aerosol particles. The PM10 concentration in urban area is significantly higher during winter.

Key-Words: Pollutants, air quality, telemetric system, traffic, city area

1 Introduction
Particulate matter with an aerodynamic diameter smaller than 10 mm (PM10) is considered a reliable indicator for possible health effects due to fine particles in ambient air [1,2]. In Europe as well as in the US and elsewhere, limit values for PM10 have been set [4]. As a consequence of the increasing consciousness about the negative health effects due to the exposure to pollutants, the European Community established limit values for PM10 (atmospheric particles with aerodynamic diameter
smaller than 10 µm) with the 99/30/EC Directive. In this Directive, the European Commission encouraged Member States to promote research for the study, physical–chemical characterization, and measurement of PM$_{10}$ and PM$_{2.5}$ as well as to prepare action plans and general strategies to abate their concentrations. In order to take efficient action against excessive exposition of people to PM$_{10}$ all quantitatively important sources of fine particles need to be known.

At present, in the urban area of Bucharest, airborne particulate matter is a pollutant of large concern because of its high concentration levels and its adverse effects on human health. In spite of the actions taken by local authorities of the Bucharest region to limit particulate matter emissions, wintertime PM$_{10}$ levels often exceed the EU limit value established for health protection. It is noteworthy that a strong seasonal effect influences PM$_{10}$ values in this area; indeed, wintertime daily concentrations and the number of the days exceeding limit values are much higher than summertime ones.

The aim of our paper is to assess the concentration levels of PM$_{10}$ in Bucharest, at traffic stations in Romania. The characteristics of the sites and the data used were presented in Section 2. The analysis of the measured concentrations to determine the number of occasions on which the 24-h mean PM10 value exceeds 50µg m$^{-3}$ was carried out. The European Union limit value requires an annual mean of 40µg m$^{-3}$ and no more than 35 exceedances annually of a 24h mean of 50µg m$^{-3}$ [5]. In addition, the correlation between traffic and regional background concentration values as well as industrial and suburban concentration values was analysed to find the sources of pollution. The direct contribution from traffic relative to the contribution from urban background has studied [7,8].

2 Sites and Data

2.1 Description of the Bucharest Area

Bucharest lies in the south-eastern part of Romania, at latitude of 44°, halfway between the Danube River and the Southern Carpathian Mountains on the banks of the Dambovita River, on 238 km$^2$. Bucharest with a population of about 2000000 by the end of 2008 has more than doubled in population since 1948.

The Bucharest air quality monitoring network has 8 stations (2 traffic stations, 3 industrial stations, 1 urban background stations, 1 regional background stations and 1 suburban background stations) [9].

The automatic stations from Bucharest present the level of pollutions, but in our study the two traffic stations was analyzed [10,11]. They are the stations of the municipal air quality-monitoring network of the Bucharest and are presented in Figure 1.

To analyze the air quality data, the telemetric systems were used. A telemeter system means any scientific instrument for observing events at a distance and transmitting the information back to the observer. Important steps to assess the air quality are the automatic network. This network is created for Romania on a few important city using automatic analyzers.

These analyzers measured the concentrations of major pollutants such sulphur dioxide, oxides of nitrogen, carbon monoxide and particulate matter (PM10). The values measured on-line using the analyzers sensor are installed on the stations from the air quality networks and transmitted through GPRS at the local center. These are inter-correlated creating a network which includes servers, where the data arrived in the real time to inform the public using control panel. This panel is situated in front of the town hall.

Meteorological data, especially the wind direction and wind intensities for each station were used. The wind regime (Figure 2) recorded values closed to the multi-annual values. Average wind speed in these sites is between 0.5 and 2.1 m/s in the northeast lower in the N, NW and S directions. Dominant wind directions is NE (10.2%), while atmospheric calm represents 89.8%.
2.2. Particulate matter
Due to its considerable lifetime and the ubiquitous spread of innumerable sources, PM$_{10}$ is a pollutant with relatively high and homogenous background concentrations in urban, suburban and rural areas [3].

In the Bucharest area, the PM$_{10}$ concentrations in street level air are dominated by the combustion, non-combustion and suspension emission originating from vehicular traffic. All largest stationary sources, such as power plants use natural gas or liquid fuel (fuel oil). At the ground level, the traffic emissions have a larger relative influence than the stationary emissions, which are mostly released from higher altitudes.

The PM$_{10}$ concentrations were measured continuously with gravimetric sampling. Since the highest PM$_{10}$ concentrations occur in the winter period (Figure 3), due to unfavourable meteorological dispersion conditions, the calculations have only been performed for the winter period.

![Fig.3 Seasonal PM10 concentration values for the monitoring stations](image)

Fig.3 Seasonal PM10 concentration values for the monitoring stations

3 Results and Discussions
The seasonal averages values of PM10 concentration at the air quality monitoring stations – traffic stations (Cercul Militar and Mihai Bravu) within the Bucharest area are presented in Figure 3. The highest concentration values are in winter.

The highest 24-h averages of PM$_{10}$ and the number of exceedances for the daily average over the limit values of 50µg m$^{-3}$ can be extracted from Figure 4. One can observe the highest values at the traffic station, in winter. Most of these exceedances occurred in February and January, both at the background stations and the traffic and industrial stations. The PM$_{10}$ annual median concentrations traffic stations are listed in Table 1. The highest 24-h averages of PM$_{10}$ and the intense pollution episodes for all the stations are also given in Table 1.

![Fig.4 The PM10 24- h concentration values for the year](image)

**Fig.4 The PM10 24- h concentration values for the year**

Table 1- PM10 concentrations at the traffic stations in the Bucharest area in 2005

<table>
<thead>
<tr>
<th>Station</th>
<th>Station classification</th>
<th>PM$_{10}$ median (µg m$^{-3}$)</th>
<th>PM$_{10}$ 24h max. (µg m$^{-3}$)</th>
<th>Pollution episodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mihai Bravu</td>
<td>Urban traffic</td>
<td>54</td>
<td>201</td>
<td>1-4 Jan.; 14-16 Jan.; 7-14 Feb.</td>
</tr>
</tbody>
</table>

These conditions are typical meteorological characteristics for the local pollution episodes. Also, the back-trajectories of air masses (Figure 5 and Figure 6) confirm local origin of the pollutants. During February episode the air masses arriving, originated from the relative non-polluted regions in northerly direction. We
analysed the air masses back-trajectories at 500, 700 and 1500 m altitude for 96 hours, arriving at 00h over Bucharest. The HYSPLIT 4 model [4] with the Global FNL meteorological archive was used.

The temperature along the trajectories confirms the very cold air masses at the three altitudes. The episodes observed during March and September (Table 1) are characterized by PM$_{10}$ concentrations at regional background site smaller than urban traffic sites and consequently, the local contributions, especially the traffic are responsible for air pollution.

4 Conclusion
We have studied the variability of the PM$_{10}$ concentrations in the Bucharest area, especially in winter, because the strong pollution episodes in this season. The selected episodes of highest PM$_{10}$ concentrations were studied related to local pollution and long-range transport of pollutants. The criterion for selecting the episodes was the daily average concentration of PM$_{10}$ exceeded with 30 percents the 50µgm$^{-3}$ values, considering these exceedances as strong pollution events. The meteorological conditions and the back-trajectories analysis helped us to decide about local or long-range pollution.

References