First magnetic measurements on PM10 filters from two stations in Serbia and comparison of the results with those from nine Hungarian stations

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Summary

We are presenting the results of magnetic susceptibility measurements carried out on PM10 filters collected at two stations in Serbia from July 1st to 31st October 2011 and compare them with those from 9 stations in Hungary, located at different settings and monitoring PM10 derived from different anthropogenic sources. As the vast majority of the magnetic grains in PM10 are derived from anthropogenic sources, it stands to reason to say that variations in magnetic susceptibility are more closely related to pollution than the mass of the dust. Comparison between susceptibilities measured on filters from Hungarian and Serbian stations (Novi Sad and Veliko Gradište) reveals that the latter are polluted similarly to Győr, a Hungarian town with fairly heavy traffic. The difference, however, is that in Győr, Sundays are less polluted than weekdays, while in the Serbian towns such trend is not observable (reason can be no camion stop). Miskolc, an industrial town with heavy traffic in NE Hungary shows twice as high susceptibilities as the previously mentioned locations, while the rest of the Hungarian stations investigated are just moderately polluted (values are only somewhat higher than those for a background station).

Introduction

Earlier, air pollution was monitored in Europe by collecting settled dust at a network of stations on monthly basis. More recently, this method was mostly abandoned and the finer fractions (PM10 or even PM2.5) of the airborne dust have been trapped and the mass of the pollutant measured on a daily basis, as it is the tiny particles which are the most dangerous for the health.

The airborne dust is composed of natural and anthropogenic particles. Among the latter, magnetic grains are much more abundant than in the former. Theses particles are emitted by industrial sources (e.g. iron works, cement factories), by vehicles or by heating devices. The contribution of anthropogenic magnetic particles to the dust is easily detected by measuring the magnetic susceptibility of the dust. This is a fast, cheap and non-destructive method and the magnetic susceptibility interpreted together with the mass of the dust, with meteorological information, etc. can orient better about the source of the airborne dust than the routinely monitored parameters.

Method and results

The Serbian PM10 samples are from Novi Sad and from Velko Gradište, representing the time from beginning of July till the end of October, 2011 (Fig. 1). At these stations the PM10 fraction of 55 m^3 air pumped through the system each day was collected. The magnetic susceptibilities of these filters and also of some Hungarian filters were measured in two laboratories, the Paleomagnetic Laboratory of Geological and Geophysical Institute of Hungary and that of Republic Geodetic Authority of Serbia with different instruments (KLY-2 and MKF1-A, respectively). The inter-laboratory checking showed that the values measured in the two laboratories were fairly close. This makes a solid basis for the comparison between Serbian and Hungarian air pollution situations. In order to do it properly, however, the introduction of a correction parameter was needed, since the volume of the air pumped through the PM10 stations in Hungary were 13.09 times higher than in Novi Sad and in Velko Gradište. Thus the measured susceptibilities on the Serbian filters were corrected and thus used for comparison with the Hungarian filters. We call the susceptibilities thus defined “apparent”, for neither the mass nor the volume of the pollutants are taken into account.

The station in Novi Sad is in the centre of the town, where the vehicle traffic is heavy, despite of the fact that the motorway connecting Budapest and Belgrade is running quite far to the west of the town. Veliko Gradište is at the boundary to Romania (heavy vehicle traffic on road and on the river) where the east wind is expected to bring industrial pollution to Serbia. Unfortunately, the most polluted three filters from the latter station (a set of Friday to Sunday samples from August) were not obtainable for magnetic susceptibility measurements, since their heavy metal content was immediately analyzed preventing any other type of investigation.

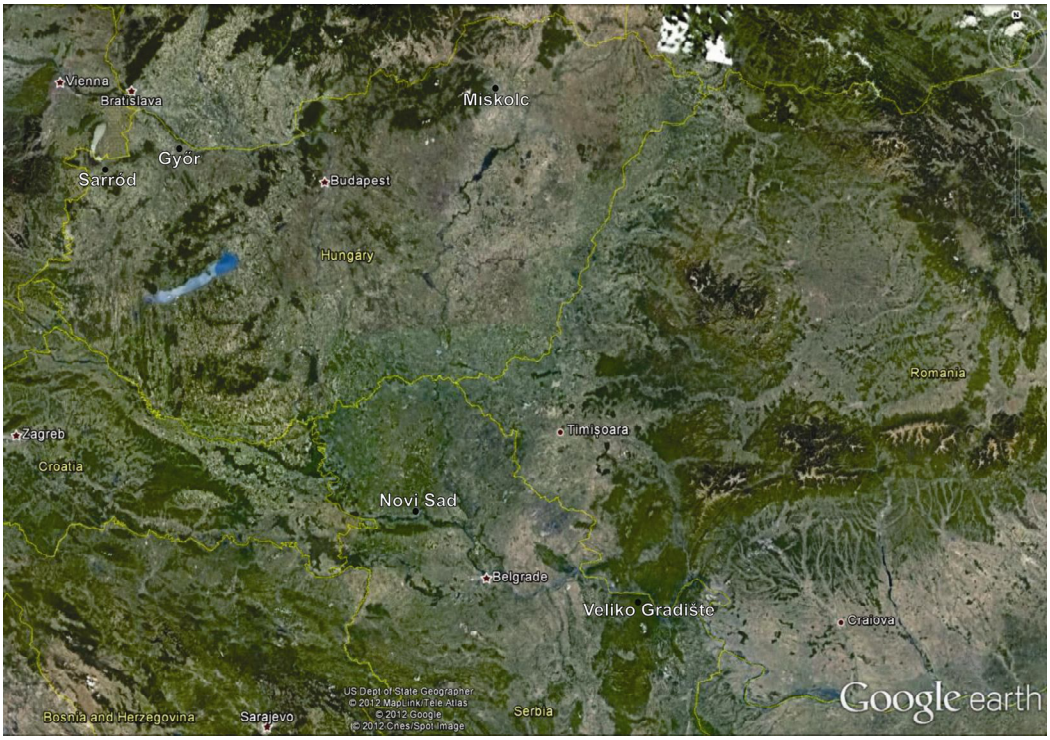

Figure 1 *Locations of the studied PM10 stations in Hungary and Serbia.*

The degree of magnetic pollution in Novi Sad, expressed by the apparent susceptibilities (without correcting the measured magnetic susceptibility for volume or mass of the dust) stacked for each of the day of the week for July, August, September and October vary between 6 and 10 x 10^{-6}SI, while in Veliko Gradište the values are 3-9 x 10^{-6}SI (as said before, without the most polluted samples). In the data from Novi Sad (Fig. 2) there is a week tendency for less magnetic pollution on Sundays than in the weekdays, except for September. An other feature of the data is that there is no significant difference between the degrees of pollution in the different months. The observations are quite different for Veliko Gradište (Fig. 2), for Sundays are not really less polluted magnetically than the other days of the week (there is no camion stop) and August for some reason yet unknown is definitely less polluted (even if we calculate with the loss of one set of the most polluted Friday-Sunday samples) than the other three months.

For the Hungarian stations the data sets represent four seasons (the filters are collected for two weeks periods in February, May, August and November) of more than two years. Due to the distribution, length, and the operation of a background station in Sarród, so far they are more suitable to estimate the role of different sources of pollution in producing anthropogenic dust. It was possible, for instance, to estimate the contribution from traffic, from household heating, from industrial sources to the pollution (Márton et al., 2012).

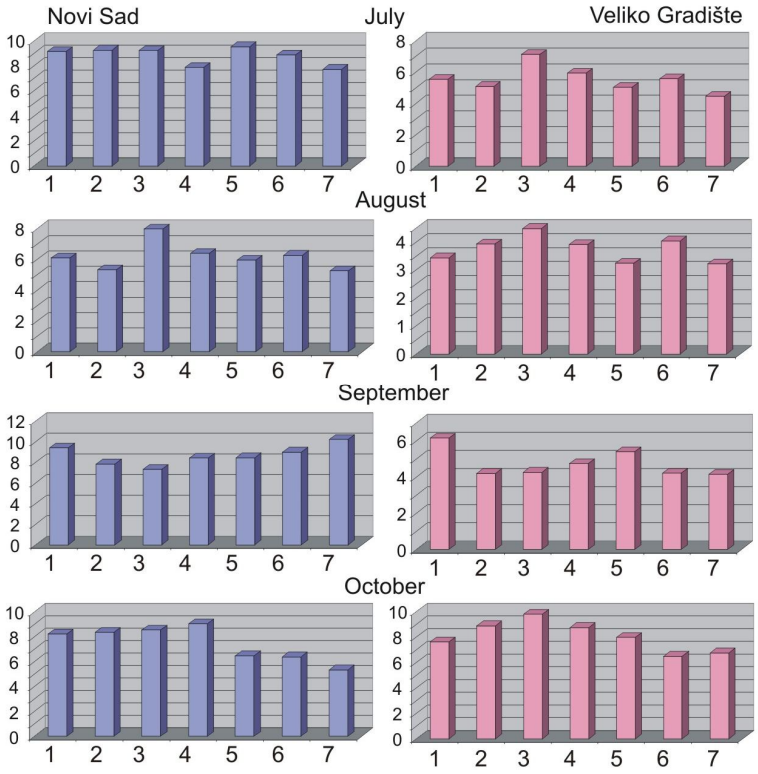

Figure 2 *Cumulative apparent susceptibility divided by the number of days of collection of PM10 filters from a station in Novi Sad and in Veliko Gradište. Numbers on the vertical axis present the apparent susceptibility (10^{-6} SI) and numbers on the horizontal axis (1 – 7) days in a week (Monday – Sunday).*

Nevertheless, comparison of Serbian and Hungarian data sets for the period of July-October permits to conclude that the degree of magnetic pollution in Novi Sad and Veliko Gradište is comparable to that of Győr (Fig. 3), Miskolc is much more polluted, while the rest of the Hungarian stations exhibit less magnetic pollution.

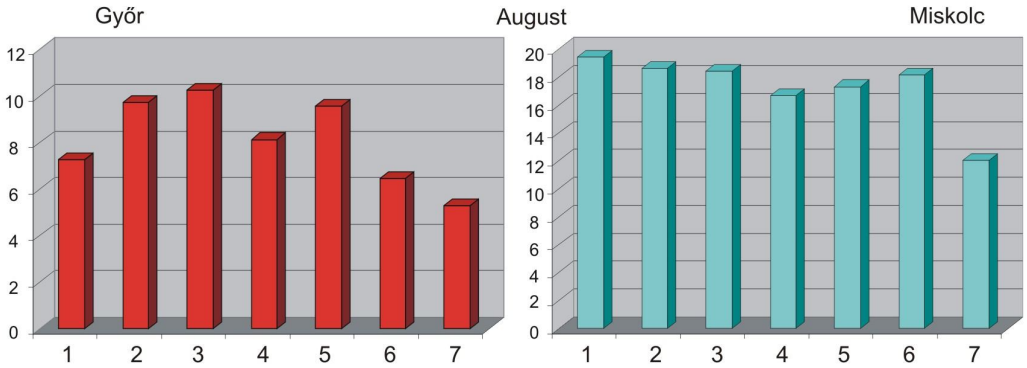

Figure 3 *Cumulative apparent susceptibility divided by the number of days of collection of PM10 filters from a station in Győr and in Miskolc. Numbers on the vertical axis present the apparent susceptibility (10^{-6} SI) and numbers on the horizontal axis (1 – 7) days in a week (Monday – Sunday).*

Conclusions

Magnetic pollution as reflected in the magnetic susceptibility of airborne dust (in our case in the PM10 fraction) collected at two Serbian stations seems to be a reliable marker of the degree of anthropogenic contribution to PM10. The Serbian data are limited to the months of July - October of a

single year (heating season is not monitored), and information additional to the apparent susceptibilities are not yet available (e. g. mass of the PM10, wind direction), therefore conclusions as to the importance of different sources can not be drown at present. In the near future, however, since an official agreement between the Republic Geodetic Authority and Agency for Environmental Protection was signed, the above problems will be solved and the non-destructive and fast method of susceptibility monitoring of the pollution will be widely applied also in Serbia to estimate the contribution of different anthropogenic sources to airborne dust.

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Reference:
Márton, E., Domján, Á., Lautner, P., Szentmarjay, T., Uram, J., Tóth, I. 2012: Magnetic monitoring of long-term PM10 records from stations of different environments and sources of pollution in Hungary. 13th Castle Meeting, Paleo, Rock and Environmental Magnetism. Zvolen, Slovakia. Contributions to Geophysics and Geodesy special issue.