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Reply on RC3

Jan M. Michalik et al.

Author comment on "Magnetic fraction of the atmospheric dust in Kraków – physicochemical characteristics and possible environmental impact" by Jan M. Michalik et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-462-AC4, 2022

In my opinion, the work is poorly organized, which makes it difficult to read. First of all, the authors did not include the purpose of the work, which makes its evaluation much more difficult. It is not clear what the authors wanted to focus on and, as a result, what they wanted to show.
The aim of the study was to characterize magnetic fraction of aerosols in Kraków. Collection of the analytical material is very important in such study and the simple passive sampler was prepared and presented in the manuscript. Suitable explanation related to the aim of the study will be added in the text.

Introduction section - there is no presentation of research results on the magnetic fraction of various types of dust.
Data related to different types of magnetic dust are presented briefly in the discussion for comparison with our results. In our opinion "general review" of magnetic fractions of various types of dusts in the Introduction would result in repetition of data and significant extension of the text.

Methods section - it is required to complete the information on the research area (reasons why Krakow was chosen), detailed information on the method of collecting samples, and some details on the measurement methods.
This subject was already raised by the referees. In "Reply on RC1" we have agreed, that more information is needed. Consequently a map will be added to the final version of the manuscript. In "Reply on RC2" we have included the "Supplementary Information 1" ("SI_1") where the sampling area is described as well as some more information on the sampler. This will be extended with the explanation given in "Reply on RC1". We find it is better not to include too much in the main manuscript as it moves the readers focus to the technical issues.

In my opinion, the Result and Discussion section should be separated, the first section should present the results (data should not be included in the captions of the figures see Fig. 3 and 4).
This was already said by other referees and we include all the mentioned results in the "Supplementary Information 2" ("SI_2") – see "Reply on RC1".

Discussion section - here the results of the research should be discussed in accordance with the purpose of the work.
I agree with most of the comments of two earlier Reviewers, so I will not repeat them.

Other commands:
It should be remembered that the magnetic fraction of dust, in fact, are mainly ferromagnetic minerals, sensu lato, with relatively strong magnetic properties. The remaining particles (after separation) also have magnetic properties: para- or dia-. So, in this method of separating magnetic particles, do we get rid of particles that exhibit paramagnetic properties? This issue was not discussed.
We will add the discussion in the final version of the manuscript.

l. 28 how to understand "dust fall samples"
The term "dust fall samples" is widely used and defined in 60-ties (DOI: 10.1080/00022470.1966.10468490), it is commonly used nowadays (e.g. cited papers by Liu et al. 2019; Magiera et al. 2010) to describe deposition of dust from the atmosphere.

l. 35 what size is considered to be magnetite nanoparticles
The referred line corresponds to the cited reference (Zhang et al. (2020), Zhang Q., Lu D., Wang D., Yang X., Zuo P., Yang H., Fu Q., Liu Q., Jiang G., 2020. Separation and Tracing of Anthropogenic Magnetite Nanoparticles in the Urban Atmosphere. Environ. Sci. Technol. 54, 9274−9284. https://doi.org/10.1021/acs.est.0c01841. In that paper we find what follows:
„Interestingly, we find that the magnetite NPs extracted from PM2.5 highly resemble the mixture of road traffic- and CFAderived particles (see Figure 3a,i,n). Particle size distribution obtained by nanoparticle tracking analysis (NTA) shows that the road traffic-derived magnetite displays a relatively broad distribution from 80 to 230 nm with two feature peaks at 126 and 177 nm (Figure 3s), probably resulting from the two distinct origins of the particles (i.e., combustion and noncombustion sources). The CFA-derived magnetite exhibits a narrow size distribution from 80 to 120 nm with only one feature peak at 97 nm (Figure 3t), which is consistent with the result obtained in TEM (Figure 3n). Noteably, the PM2.5- derived magnetite shows three feature peaks at 100, 122, and 200 nm, which may correspond to the sum of the particles derived from road traffic and CFA (Figure 3u). We infer that the peak at 200 nm may shift from the peak at 177 nm probably due to some minor sources or particle aggregation during atmospheric transfer process.
It is worth noting that NTA is a light scattering method and evaluates the particle diameter on the basis of tracing the Brownian motion of particle diffusion.42 The best working range of NTA for particle size analysis is 50−1000 nm, because particles smaller than □50 nm scatter much less light, so smaller particles tend not to be detected; meanwhile, for particles larger than □1 μm, their Brownian motion is too small to allow their diameters to be extracted from the images. Thus, although a number of small particles (<50 nm) are observed in TEM (Figure 3a), they are omitted in NTA. Furthermore, the presence of aggregates of small magnetite particles may also be counted as large particles (Figure S11). Therefore, for comparison, we have also performed the particle size statistics based on TEM counting. The results are given and discussed in Figure S12. Comparing the results between TEM and NTA, TEM gives more information in the small size range, while NTA, as a bulk measurement technique, can cover all particles in a sample to avoid possible bias caused by particle selection. In addition, the particle size obtained by NTA is hydrodynamic in diameter, which is normally larger than that obtained by TEM.43 In spite of the discrepancy mentioned above, the profiles of particle size distribution obtained by these two techniques are largely similar."

l. 43 PM is an abbreviation; particulate matter
"filters containing PM10 particulate matter" was used in the text (line 43) to indicate that PM10 fraction of the total particulate matter occurring in the atmosphere was analysed. For simplicity we will cancel "particulate matter" in the final text.

l. 262-263 In Magiera et al. 2021, I did not find information "possibility of superparamagnetic particles being present in the suspended particulate matter was

discarded by some authors on the basis of the magnetization measurements"
In cited reference the authors say (page 9, second but last paragraph):
"There is also a theoretical possibility that some contribution to this component is made by fine magnetite particles that are close to the SD/superparamagnetic boundary, which has clearly reduced hyperfine field due to spin relaxation effects. However, this result was in contrary to the magnetic measurements (low χfd%). In general, the precise distinguishing among the phases ascribed to the G06 component is impossible due the broad overlapping lines and the similarity of the hyperfine parameters."
Then, in the same reference (page 12, first full paragraph):
"Very low values of frequency dependence of magnetic susceptibility, usually less than 2.0%, suggests that the content of superparamagnetic grains is negligible. Only areas influenced by long-range transport from other industrial sources (power plants coke plant) located in long-distance, exhibited the considerable admixture of SD particles and higher χfd% values (>4.5)."
Consequently we propose to change the sentence in lines 266-270 from:
"On one hand, a possibility of superparamagnetic particles being present in the suspended particulate matter was discarded by some authors on the basis of the magnetisation measurements (Magiera et al., 2021). On the other, the possibility of the long-range transportation of tiny (a few nanometres to a few tenths of a nanometre in diameter) particles far from the industrial sources cannot be eliminated."
To:
"On one hand, a negligible content of superparamagnetic particles in the suspended particulate matter was reported by some authors (e.g. Magiera et al., 2021) on the basis of frequency dependence of magnetic susceptibility analysis. On the other, the possibility of the long-range transportation of tiny (a few nanometres to a few tenths of a nanometre in diameter) particles far from the industrial sources cannot be eliminated, as was also proposed by the same authors."

What about interpretation of curves zero field cooled (ZFC) and field cooled (FC)? Typically, a well-defined maximum in the ZFC curve is associated to blocking temperature of superparamagnetic nanoparticles of well-defined size. However, for broad distribution of nanoparticles' sizes such maximum is usually not observed. This is apparently our case, as the ZFC curve shows no maximum but constant raise up to the room temperature. Appropiate discussion will be added.

Several references cited in the text are not included in the references section.
This issue will be addressed in the final version of the manuscript.