Diurnal and seasonal variations of (nano)aerosols in the Škocjan Caves, Slovenia, a natural treasure of planet Earth

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The Škocjan Caves are one of the most important cave systems in the world; they represent the most significant underground phenomena in the Karst region and Slovenia as well. Since 1986 Škocjan Caves were on the UNESCO's list of natural and cultural world heritage sites. Since the caves are opened to the public for a longer time, the possible pollution coming from the outside ambient air and additionally the influence of visitors can represent a real danger for this natural treasure. The important activity of the Škocjan Caves Regional Park, Slovenia is to monitor the parameters over the long period of time as it will be possible to detect the negative effects on the environment, and further timely react and prevent the potential damage.

In addition to the climatic conditions and radon activity concentration usually measured in the caves (e.g. Sainz et al. 2007), aerosol particles should also be measured as important factor. However, due to the extreme conditions in the caves (e.g. high relative humidity), especially if the sampling instrument is not adapted for such conditions, difficulties in aerosol measurements can be expected. This is likely the reason for low number of papers on aerosols in the caves (Kertész et al. 2002).

In this study, the continuous aerosol measurements during three different sampling periods were performed in the Škocjan Caves. To get information about the background aerosol concentration, the first measurement campaign on PM_{10} and size distribution of aerosols was carried out in December 2011. During June and August 2012, when a higher number of visitors is usually expected, the aerosol size distribution and number concentration of nano particles were additionally followed. Furthermore, PM_{10} measurements were performed also outside the cave to observe the possible influence of atmospheric particles.

Background concentration of PM_{10} was found to be about 4 µg m^{-3}; higher concentration was measured in June, and particularly in August 2012. It can be suggested that the increase in the aerosol concentration inside the cave was connected to both, the polluted atmospheric air which enters the cave with opening the door and to the higher number of visitors. Measurements of nano particles with SMPS additionally confirmed these findings. During summer period a severe raise in total aerosol concentration was determined (up to 18,000 particles cm^{-3}). Our results demonstrated that we were really able to detect very small changes and variations in aerosol concentration inside the cave. To our knowledge these are the first results on nano aerosols in the cave at all, and we believe should be considered seriously to protect the cave environment against their potential negative effects.

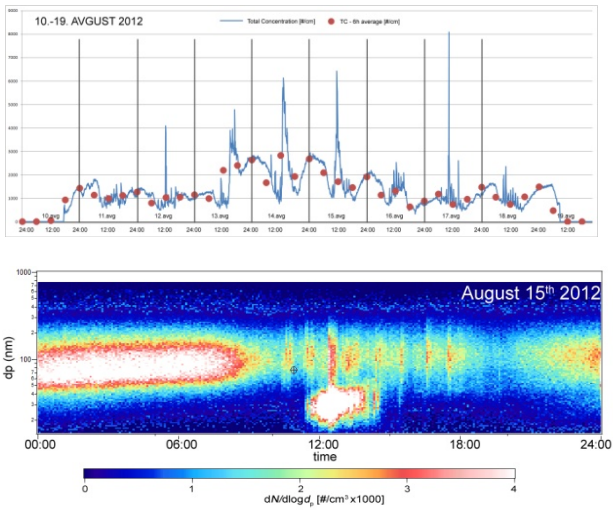

Figure 1. Total number conc. of particles between 14 nm and 710 nm for period 10 - 19 August 2012; and number conc. (particles cm^{-3}) and size distribution of the particles measured in the Škocjan Caves, Slovenia on 15 August 2012, using SMPS (TSI).

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