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AEROTAPE: A NOVEL TECHNOLOGY FOR REAL TIME QUANTIFICATION AND CHARACTERIZATION OF DUST AND ITS SOURCES

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EU Member states are allowed to subtract the PM10 contribution from natural sources (such as desert dust or sea salts) from the observations, when verifying compliance with air quality standards. However, they must do so with pertinent data, which can be sometimes challenging. The recent EU Air Quality Directive enforces a drastic reduction of PM10 annual limit values (from 40 to 20µg/m3) and daily limit values (from 35 times above 50µg/m3 to 18 times above 45µg/m3) by 2030. These constraints will increase the need to apportion carefully natural and anthropogenic PM sources in the coarse fraction with a particular attention to traffic sites. In fact, the latter exhibit high PM concentrations and are exposed to various local (road traffic resuspension) and regional (long-range transported) dust sources. We present here a novel analyser instrument that focuses on super micron particles, named AEROTAPE, which is developed at Oberon Sciences, France. AEROTAPE samples atmospheric particles within the range of 0.8 –10 µm diameter. The Aerotape's impactor collects particles onto a transparent adhesive tape, after which an on-board microscope takes an image and sends it to a data server for hourly processing. The sample is illuminated at different angles and at different wavelengths to deduce particle size and nature using the on-board camera. The tape is uncoiled at variable velocity to prevent picture saturation. This technique enables the sampling of extremely concentrated aerosol conditions by preventing over-deposition in the optical stage. Sampling is performed over a three-minute period at a flow rate of 15 L/min. An artificial intelligence (AI) module automatically processes the pictures of the collected particles, taken at a frequency of up to 0.5 Hz. This allows real-time differentiation of particle types, as well as the derivation of particle size and shape distribution. The added value of AEROTAPE compared with a traditional Optical Particle Counter (OPC) is the use of a camera instead of a laser/detector system, which allows visual information on the geometric shape of the particles as well as their colour using an RGB array. Moreover, the image processing algorithm allows to measure the area of individual particles and at the end a geometric size. By providing detailed information on particle shape and colour, the Aerotape will allow for improved differentiation between particle types such as dust, pollen, and combustion ash, thus enabling a more accurate assessment of natural contributions to PM levels. Results presented here highlight the metrological (accuracy and precision) performance of the AEROTAPE in measuring PM in the coarse fraction and counting super micron aerosols in different size fractions. Strong correlation between the simultaneous observation with two AEROTAPEs confirmed the very good precision of the instrument while its accuracy was assessed against reference devices such as TEOM – 1405 as well as other commercial OPCs (FIDAS, GRIMM, PoPs).

We plan to further optimize the Aerotape technique through a series of field campaigns, allowing us to collect particles from diverse locations influenced by different sources. This will provide a robust dataset for training and refining particle classification methods. One aim is to characterize PM dust from transportation emissions in different regions and climates, via intensive field campaigns conducted at traffic sites in Paris (France) and Limassol (Cyprus). Moreover, desert dust will be characterized during intensive field campaigns in the UAE and Cyprus, combined with remote sensing and in-situ monitoring technologies (drones, balloons, and ground-based). This will help create a database of PM dust sources in cities and address the quantification of local vs regional dust.

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