Real-time Air Quality Monitoring with a Novel Aerosol PM Monitor

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Ambient air quality is monitored around the globe and aerosols are one of the main constituents in the focus. The EU has set limit values for particulate matter (PM), which typically are determined by the European reference method for measuring the PM10 or PM2.5 mass concentration in ambient air.

The reference method relies on the gravimetric sampling of PM on filters over 24 hours and weighing them by means of a balance. A variety of techniques have been qualified as equivalent methods, including the Tapered Oscillating Element Monitor (TEOM) and the Beta Attenuation Monitor (BAM). Both technologies are widely used and can be very precise, given the right operating conditions, but come at a cost.

In many applications, an indicative measurement with an instrument that carries a higher measure of uncertainty will be adequate. This is in particular the case if lower cost of ownership makes the operation of multiple units and thus a better spatial resolution economically sustainable. Examples include unattended monitoring e.g. of industrial hot spots, construction sites, wildfires and at roadsides. It is for such measurements as well as for supplementing routine air networks that the new Environmental DustTrak (EDT, TSI Inc., Shoreview, USA) was developed. The EDT provides real-time, near-reference ambient aerosol monitoring using light scattering photometric technology at a fraction of the cost of other methods.

The core measurement technology inside the EDT is based on the well-proven DustTrak II and DRX instruments (TSI Inc.; Wang et al. 2009). The different EDT versions can measure either PM2.5, PM10 or simultaneously total PM, PM10, PM2.5 and PM1. The monitor is installed in an environmental housing that can be equipped with omnidirectional sampling inlet, heated inlet, auxiliary metrological sensors, and remote data transfer online. Data can be robust and secure accessed via the internet with the ability of auto-alert notifications when predefined limits are exceeded. The EDT was designed with a robust pump and a built-in auto-zero module for reliable outdoor ambient measurements. Photometers are direct reading, real-time instruments that provide near-reference measurement of aerosol mass (PM fractions). The EDT allows custom calibration factors to be used to allow a close alignment of the photometric values with the actual gravimetric mass data in a given location.

A critical factor for outdoor aerosol measurements is ambient relative humidity (RH) which can significantly change the particle size and mass, especially for hygroscopic aerosols due to their water-uptake. Photometric measurements based on light scattering are also affected by hygroscopic particle growth at elevated RH due to an increased scattering signal (e.g. McMurry et al. 1989 and Day et al. 2000). Therefore conditioning of the aerosol to a lower RH is recommended. The EDT achieves this through its heated inlet that lowers the RH by increasing the temperature in the inlet depending on both ambient RH and temperature. In Figure 1 we show the EDT performance with and without heated inlet for an ambient aerosol at a site in Singapore with predominately high RH. The differences in measured PM2.5 concentration are ca. 30% or even higher, confirming the need for aerosol conditioning before PM measurement.

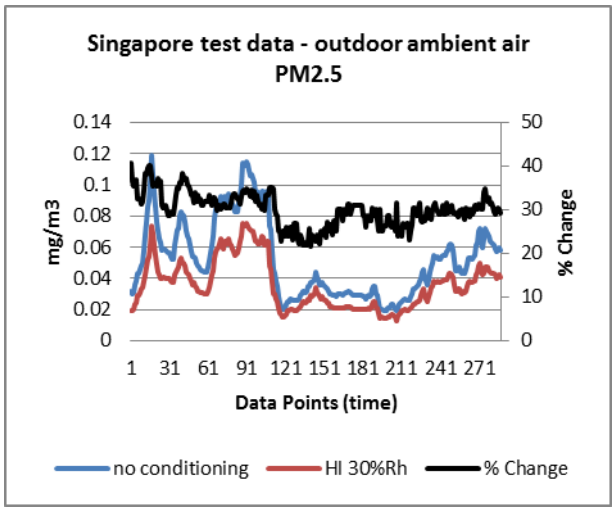

Figure 1. PM 2.5 data measured over 24-hours by the EDT without (no conditioning) and with heated inlet (HI 30% RH). The black line is their relative difference.

We have tested the EDT in the field side-by-side to equivalent instruments and other near-reference instrumentation. The overall correlation is good but typically slightly better for PM2.5 comparisons than for PM10. We will present results from laboratory and field studies conducted with the EDT during the past year.

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