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The effect of season and microenvironment type on measurement bias of a photometer DustTrak

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In the last decade, light scattering devices (or photometers) have been widely used for continuous recording of particulate matter concentrations in exposure assessment studies. The principal advantage of these instruments is that they can be used not only for static but also for personal monitoring since they are portable and can operate on batteries which sustain usually longer than 24 hours. One of the most widely used devices is the DustTrak nephelometer (TSI, Model 8520). It is a real time photometer suitable for determination of aerosol mass concentrations between 0.001 and 100mg/m^3 for particles ranging in size from 0.1 to 10μm. As the instrument is calibrated by the manufacturer for Arizona dust (ISO 12103-1, A1 test dust) the values obtained from measurements performed in various types of indoor and outdoor microenvironments where the particles differ substantially are not actual gravimetric values. In previous studies using this type of device several attempts have been made to establish a recalculation/correction factor according to which the DustTrak data can be transformed into "real" gravimetric values (Chung et al., 2001; He et al., 2004; Heal et al., 2000; Jenkins et al., 2004; Lehocky a Williams, 1996; Levy et al., 2003; Moosmüller et al., 2001; Morawska et al., 2003; Ramachandran et al., 2003; Yanoski et al., 2002 and others). We present here the results of a long term collocation of Dustrak ($PM_{2.5}$) and a cascade impactor (PCIS). Our results showed that the correlation coefficients between the DustTRak and PCIS $PM_{2.5}$ concentrations were reasonably high, 0.922 and 0.936 for the outdoor and indoor microenvironments respectively.

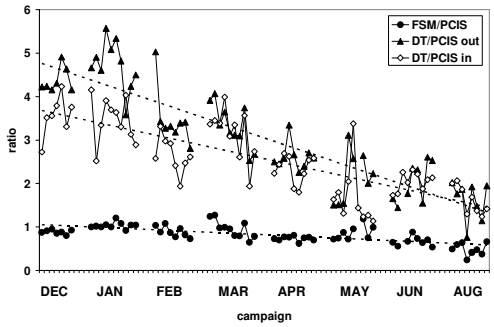

Figure 1: Ratio between $PM_{2.5}$ measured during different seasons in indoor and outdoor microenvironments by DustTrak and two other methods (PCIS and β-attenuation).

However, the 24-hour DustTrak values were in all cases higher than the PCIS ones (Fig. 1). The photometer gave values ranging from about less than 2 to over 5 times higher than the reference method. Higher DT/PCIS ratios were found in winter and in situations when smaller particles were abundant in the measured aerosol mixture.

Together with other authors we conclude that DustTrak is a good device for recording relative changes in aerosol concentrations but cannot be used for estimation of real PM mass concentration. However, with parallel gravimetric measurements a correction factor can be obtained and used in short term exposure assessment studies. When no simultaneous reference measurements are available, recalculations of DustTrak readings to gravimetrical values cannot be simply made on the basis of the existing literature data. Seasonal (temperature and relative humidity), specific microenvironmental characteristics (indoor, outdoor) and type of aerosol sources should be taken into account.

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