Application and recalibration of a GRIMM spectrometer in the monitoring of Sahara dust

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Optical Aerosol Spectrometers are relatively inexpensive devices employed in the measurement of aerosol concentrations with basis on the univocal relation between particle size and its light scattering properties. Optical Aerosol spectrometers are only sufficiently sensitive to particle size ranges above 200 nm, being specially adapted to measure coarse aerosols such as dust and sea salt spray.

A GRIMM optical aerosol spectrometer, model EDM164, was deployed for monitoring, during one year, the atmospheric aerosol in Cape Verde, region periodically subject to important Sahara dust intrusions. The device was pre-calibrated at the factory with Poly Styrene Latex (PSL) particles. With the GRIMM, numeric size distributions between 0.25 and 32 um, in 31 size bins, were determined as 5 minutes averages along 2011. In parallel the aerosol was co-collected with PM2.5 and PM10 samplers and concentrations determined gravimetrically after 1-2 days of sampling. In a number of occasions parallel sampling was performed also with impactors, for mass size distribution evaluation.

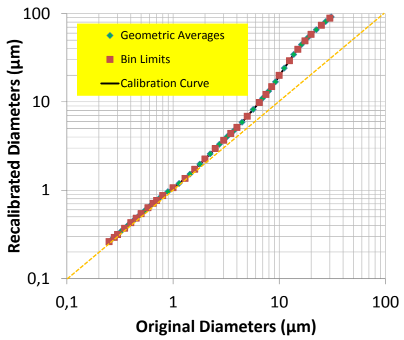

Figure 1- Recalculation of GRIMM particle size diameters using Mie theory, for dust particles having refractive index= 1.53-0.005i.

Using predictable aerosol particles density the GRIMM number concentrations were transformed into mass concentrations. These were intercompared with PM gravimetric concentrations, taking into account PM head inlet cutting characteristics and probable particle dynamic shape factors. While for $PM_{2.5}$ results were comparable, (GRIM=0.83*GRAV+0.58; R^2=0.99), for PM_{10} GRIMM concentrations were in average only 58% of the gravimetric measurements (GRIM=0.58*GRAV +1.3; R^2=0.96).

A possible cause for the results discrepancy are the different shapes and optical characteristics of the PSL aerosol used at factory calibration (Refractive Index RI=1.59) and the Sahara dust that has a brownish colour and therefore an imaginary RI component. The GRIMM calibration curve was re-calculated for Sahara type dust particles having refractive indexes in accordance with Kandler et al., (2007), by using the Mie theory adapted to the GRIMM optical geometry (software kindly provided by Thomas Mueller, Leipzig). The GRIMM recalculated values for the size distribution adapted to Sahara dust characteristics resulted in a much better agreement with gravimetric PM10 measurements (Fig. 2).

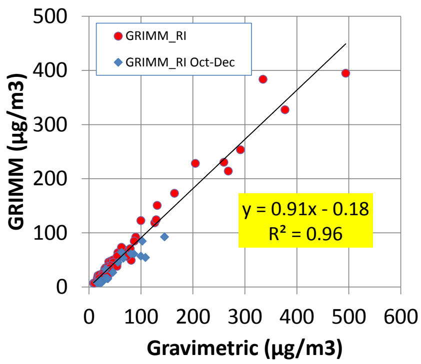

Figure 2- GRIMM and gravimetric PM10 measurement comparison, after recalibration

As seen in Figure 1 RI based recalibration has effects for size ranges above 1-2 um and becomes quite large for particles above 10 um. As result size distributions obtained with recalibrated GRIMM data present a quite high peak for particles larger than 10 um (see example in Figure 3) which does not seem expectable taking into account literature information and the size cut-off of GRIMM inlet.

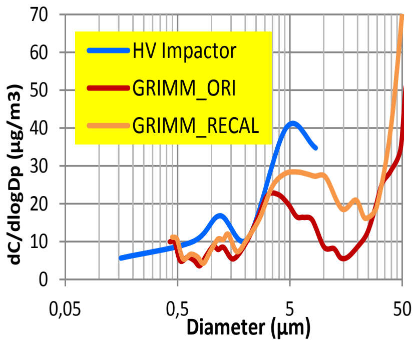

Figure 3- Comparison of mass size distribution obtained with the GRIMM and the impactor

Acknowledgement: This work was funded by the Portuguese Science Foundation (FCT) through the project PTDD/AAC-CLI/100331/2008. J. Cardoso acknowledges the PhD grant SFRH-BD-6105-2009 from FCT.

References: Kandler et al. (2007) *Atmos. Environ.*, **41**, 8058–8074