Eddy covariance aerosol flux measurements during the Melpitz Column experiment

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Keywords: particle flux, flux attenuation, characteristic response time.
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In the boundary layer, the vertical exchange of matter and energy is mainly driven by turbulence. Thus, turbulent transport determines the vertical distribution of aerosol particles as well as particle-borne nutrients and pollutants. Measuring vertical aerosol fluxes is essential in order to locate and quantify net particle sources and sinks.

In this study, vertical aerosol fluxes were directly measured by eddy covariance above the Melpitz grassland site close to the town of Torgau in Saxony (Germany) from May to June 2015. The eddy covariance setup included a sonic anemometer (usonic3, METEK, Germany) and two condensation particle counters (CPC), a commercial CPC (Model 3010, TSI, USA) and a custom-built Fast CPC (FCPC; Wehner et al., 2011). One major difference of the two particle counters is their characteristic response to fast changes in particle number, which is extremely important in order to resolve all frequencies that contribute to the total turbulent flux.

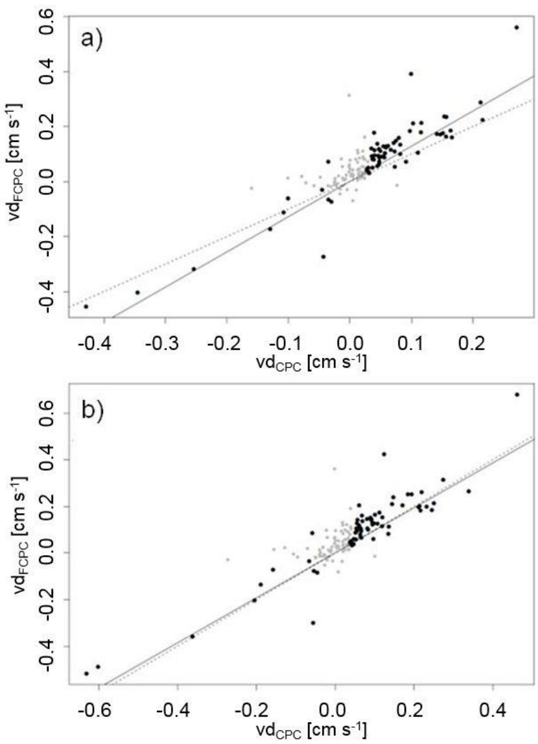

Figure 1. Comparison of deposition velocities *vd* as determined with the CPC and the FCPC a) before and b) after correction for the time response; grey data are within the uncertainty of the measurement, and not taken into account for calculating the linear regression.

With time constants of t_{CPC} = 0.68 s and t_{FCPC} = 0.17 s (Sandgaard, 2015), high frequency fluctuations of the particle number concentrations cannot be fully resolved and the corresponding aerosol number fluxes are attenuated. Here, the differences of the observed CPC and FCPC flux measurements are compared with a theoretically estimated difference due to flux attenuation.

As expected, due to the faster response behavior, the fluxes derived from the FCPC data were typically larger than the CPC fluxes. Figure 1a shows a direct comparison of the particle deposition velocity *vd*, i.e. the particle deposition flux normalized by the particle number concentration, derived from the CPC and the FCPC. The linear regression slope of 1.28 indicates that the high frequency contribution, which is only covered by the FCPC, yields 28 % higher deposition velocities on average.

Horst (1997) provides a simple correction method to estimate the flux attenuation due to a non-perfect time response. When applying this correction to the CPC and FCPC fluxes, the corresponding particle deposition velocities *vd* (Figure 1b) are close to the 1:1 line (slope of 0.97).

In conclusion, it was possible to explain the differences in particle deposition velocities derived from two co-located condensation particle counters by their characteristic response behavior, and to correct the associated flux attenuation as described by Horst (1997). However, additional reasons for the observed differences cannot be excluded. Overall, a standard CPC in combination with the Horst (1997) correction can be used for standard aerosol flux measurements. Due to the fact that this correction was up to 30 – 40 % of the estimated CPC fluxes, measurements with high time resolution as provided by the FCPC are recommended for direct eddy covariance measurements.

Horst, T.W. (1997) A simple formula for attenuation of eddy fluxes measured with first-order response scalar sensors. *Bound. Lay. Meteorol.* **82,** 219-233.

Sandgaard, J. (2015) Charakterisierung eines schnellen Aerosol-Sensors für Partikelflussmessung. B.Sc. thesis, TU Braunschweig.

Wehner, B., Siebert, H., Hermann, M., Ditas, F., and Wiedensohler, A. (2011) Characterisation of a new Fast CPC and its application for atmospheric particle measurements. *Atmos. Meas. Tech.* **4**, 823-833.