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A comparison study between linear detrending and recursive digital filter in aerosol deposition velocity evaluation by eddy covariance method

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In the last decades, ecosystem activities are continuously monitored at long-term eddy covariance (EC) research infrastructures located worldwide, in order to estimate turbulent exchanges at the land-atmosphere interface, which plays a key role in many applications. In this context, the eddy covariance technique represents the reference method for the estimation of direct aerosol turbulent exchanges. In this study, the performance of Linear Detrending (LDT) and a Recursive Digital Filter (RDF) in removing the low-frequency contribution to the calculations of aerosol vertical turbulent fluxes is investigated. The both methods are applied in order to obtain a correct evaluation of ultrafine particles, exchange velocity, separating the negative cases (named emission velocity - Ve) from positive cases (the so called deposition velocity - Vd). An ogive analysis of turbulent fluxes was carried out in order to obtain the low-frequency time scales (τc) required by the RDF for different atmospheric stability conditions (i.e. unstable, stable and neutral). RDF was applied also with a constant low-frequency time scale (RDF300, τc=300s). In this comparison study LDT has been used as method of reference. Stationarity test proposed by Mahrt (1998 - MST98) has been applied particle number fluxes with and without applying LDT and RDF methods, in order to investigate the impact of separation criteria on stationarity test performances. The novelty of this work consists in the straightforward application of the recursive digital filter to real long-case EC measurement of particle number concentration flux, assessing the performance of the two filtering methodologies, which can be applied in real-time and post-processing automated procedures. Results show that there are no significant differences in stationary cases for filtering procedures. The sensitivity analysis carried out for the main turbulent parameters highlights that wider discrepancies occur between LDT and RDF300, showing a large increase in turbulent number particles flux. Filtering procedures lead a slight increase of exchange velocity, although and underestimation occurs for emission and deposition velocities. The filtering effect of RDF manuscript strongly depends on the low-frequency time scale, which should be preferably estimated by means of spectral criteria.