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Performance of different detrending methods in turbulent flux estimation

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The eddy covariance is the most direct, efficient and reliable method to measure the turbulent flux of a scalar (Baldocchi, 2003). Required conditions for high-quality eddy covariance measurements are amongst others stationarity of the measured data and a fully developed turbulence. The simplest method for obtaining the fluctuating components for covariance calculation according to Reynolds averaging rules under ideal stationary conditions is the so called mean removal method. However steady state conditions rarely exist in the atmosphere, because of the diurnal cycle, changes in meteorological conditions, or sensor drift. All these phenomena produce trends or low-frequency changes superimposed to the turbulent signal. Different methods for trend removal have been proposed in literature; however a general agreement on how separate low frequency perturbations from turbulence has not yet been reached. The most commonly applied methods are the linear detrending (Gash and Culf, 1996) and the high-pass filter, namely the moving average (Moncrieff et al., 2004). Moreover Vickers and Mahrt (2003) proposed a multi resolution decomposition method in order to select an appropriate time scale for mean removal as a function of atmospheric stability conditions. The present work investigates the performance of these different detrending methods in removing the low frequency contribution to the turbulent fluxes calculation, including also a spectral filter by a Fourier decomposition of the time series. The different methods have been applied to the calculation of the turbulent fluxes for different scalars (temperature, ultrafine particles number concentration, carbon dioxide and water vapour concentration). A comparison of the detrending methods will be performed also for different measurement site, namely a urban site, a suburban area, and a remote area in Antarctica. Moreover the performance of the moving average in detrending time series has been analyzed as a function of the averaging windows for different scalars in different measurement campaigns.

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