Geophysical Research Abstracts
Vol. 15, EGU2013-3488, 2013
EGU General Assembly 2013

Comparison of three stationary tests for eddy covariance measurements of turbulent fluxes of different scalars

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In atmospheric turbulent flows, variables describing the motion undergo random and stochastic fluctuations. In turbulence studies the hypotheses of stationarity and ergodicity of time series is required in order to obtain estimates of ensemble averages from the temporal averages obtained from single runs. In atmosphere, however, equivalence between the two averages is just approximated because of non stationarity often inherent to atmospheric time series. Typically non-stationary conditions are driven by weather or internal boundary layer changing, for example for the presence of gravity waves or simply for the slow diurnal evolution of the boundary layer. The individuation of non-stationary cases is important for measurements of turbulent fluxes using the eddy covariance method generally applied to 30 minutes averages. Moreover it is necessary to have an analytical/parametric stationarity test, which can be used in real time determination of turbulent fluxes, for example in Fluxnet network. Nowadays different stationarity tests are proposed in literature and they are substantially used by scientific community (Foken & Wichura, 1996; Mahrt, 1998; Affre et al., 2000). In this work several time series have been analysed with the three different stationarity tests and a comparison of their performances has been developed. The stationarity tests have been applied to different scalars (temperature, ultrafine particles number concentration, carbon dioxide and water vapour concentration). All the time series come from measurements in different sites and are collected over different canopies: iced surface (in Antarctica), urban or suburban surface (Italy) and vegetal canopy over forests (both in Italy and USA). In total 6 different sites have been analysed and the performances of the stationarity tests do not seem to be site dependent. The correlation of their performances as a function of local micro-meteorological conditions have been analysed. All the three tests show difficulties operating in conditions of low winds (about 1 m/s) or in calm winds (lower than 0.5 m/s). Moreover the obtained results show that there is not a method significantly more efficient than the others. A new method based on the use a single combined index which takes into account two (or three) test results have been proposed.

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