Geophysical Research Abstracts
Vol. 17, EGU2015-15379-1, 2015
EGU General Assembly 2015

Monin-Obukhov Similarity Relations for C_{T^2}, C_{q^2} and ε based on 11 Field Experiments

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In the literature, no consensus can be found on the exact form of the universal Monin-Obukhov Similarity (MOS) functions of the structure parameters of temperature, C_{T^2}, and humidity, C_{q^2}, and the dissipation rate of turbulent kinetic energy, ε. As large variations exists between the MOS functions in the literature, the question arises what caused these variations and if MOS functions are actually universally applicable. In this study we used data from 11 datasets that were gathered over different surface types and stability ranges to investigate the universality of MOS functions. First, by combining all datasets, we were able to present robust MOS functions of C_{T^2}, C_{q^2} and ε that cover a large stability range for both unstable and stable conditions. Second, as all data were gathered with the same instrumentation and were processed in the same way — in contrast to earlier studies — we were able to investigate the universality of MOS functions by defining MOS functions for all datasets individually. We found no substantially different MOS functions of C_{T^2} and ε for datasets over different surface types or moisture regimes, which implies that these MOS functions are indeed universal. MOS functions of C_{q^2} differ from that of C_{T^2} and do differ between datasets, which is likely related to non-local effects such as entrainment or advection. Furthermore, we show that limited stability ranges are a plausible reason for variations of MOS functions in the literature. Last, we investigated the sensitivity of fluxes to the uncertainty of MOS functions. For future studies we recommend to calculate the surface fluxes with an uncertainty in the MOS function. We provide an overview of the uncertainty range for MOS functions of C_{T^2}, C_{q^2} and ε, which we suggest to use to determine the uncertainty of surface fluxes.