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The impact of varying height and stability on Monin-Obukhov similarity functions and evaluation of several fitting methods

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In atmospheric models and in the analysis of micro meteorological observations, Monin-Obukhov similarity theory (MOST) is the generally accepted method to link surface fluxes to turbulent quantities, such as the standard deviation and structure parameter. The turbulent quantities are a function of the dimensionless height z/L, with z the observation height above the surface and L the Obukhov length. The shape of the dimensionless functions differ between the turbulent quantities. In literature several expressions for the functions exist, based on a fit through data measured over a range of z/L.

In most of these studies the data is measured at one up to a few observation levels close to the surface. That means that the range in z/L, over which the functions are defined, vary due to variations in L only. In other words, z/L does only vary due to variations in atmospheric stability measured during different times of the day. Here we address the question to what extend the variations in z/L due to variations in z yield in the same functions as variations in z/L due to variations in L.As such we investigate the functions for the standard deviation and structure parameter of temperature under unstable situations, using observations at 32 levels of the 60-m tower during the CASES-99 experiment.

In addition we investigate to what extent the method of fitting has an impact by comparing classical non-linear least squares methods with orthogonal regression distance fitting. Furthermore, we investigate if the fit differs for linear, semi-logarithmic and double-logarithmic plots. The corresponding research questions are: what are the differences of the several methods of fitting and what are the advantages and disadvantages of these methods?