The effect of turbulence anisotropy on flux-gradient relations

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Flux-gradient relations from Monin Obukhov Similarity theory (MOST) allow to predict the turbulent fluxes in the Atmospheric Surface Layer from the profiles of wind and temperature and are used in most numerical weather models. These relations were derived under the assumption of homogeneous and flat terrain, constancy of fluxes with height and no subsidence. Various turbulence experiments during the last 50 years have allowed to derive the empirical form of the universal functions, however their form disagree in very stable and very unstable regimes and they still present unexplained scatter.

In this work we explore the validity of MOST flux-gradient relations for mean temperature and wind speed using the local scaling approach, employing five well-known turbulence datasets ranging from flat and weakly heterogeneous terrain to more complex terrain and covering the entire stability range. Using these data, we show how including turbulence anisotropy as an additional scaling parameter can greatly reduce the scatter and clarify the shape of the universal scaling relations. As a result of this study, new parametrizations are provided for the scaling of the dimensionless wind and temperature gradient, that are function of both the stability parameter z/L and anisotropy.