Exploring the potential of mass flux concepts for momentum transport in the dry convective boundary layer

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Non-local transport and entrainment due to large rising thermals are typical and dominant features of the Convective Boundary Layer (CBL). For heat and scalar fluxes this is generally accepted implying that local diffusion alone is not an appropriate concept. To account for these effects different parameterizations, such as counter-Gradient (CG) and explicit entrainment schemes have been developed. Most recently also Mass Flux (MF) concepts, which primarily have been used for cumulus parameterizations, have been adapted highly successfully for the dry CBL. Such MF schemes were shown to be capable of simulating both non-local transport as well as entrainment. In the case of momentum transport, however, the role of non local-effects is not well understood. In atmospheric models momentum transport in the sub grid scale is mostly treated as a pure local diffusion process, which leads to systematic errors in the simulated wind fields. Investigation of Large Eddy Simulation (LES) results and observations indicate that non-local effects are also important for the transport of momentum. A deeper understanding of these processes is still missing and no consensus exists in the literature to what extent turbulent transport of momentum in the CBL could also be interpreted in a mass-flux-framework. In the present study we analyze LES data of dry CBLs with vertical wind shear and we investigate similarities and differences between the turbulent transport processes of thermodynamic variables, scalars and horizontal momentum. As such we analyze the momentum budget of updrafts and evaluate the potential of different mass flux formulations to account for momentum transport associated with large convective structures in the CBL.