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Role of convective structures and background turbulence in dry convective boundary layers

A. Hellsten (1) and S. Zilitinkevich (1,2,3)

(1) Finnish Meteorological Institute, Helsinki, Finland, (2) Division of Atmospheric Sciences, Department of Physics, University of Helsinki, Finland, (3) Department of Radio Physics, N.I. Lobachevski State University of Nizhniy Novgorod, Russia

This study quantifies the role of the convective buoyant structures and the remainder turbulence, here called background turbulence, in convective atmospheric boundary layers in horizontally homogeneous, dry and barotropic conditions. Three filtering methods to separate the structures and the background turbulence are first evaluated. These are: short-time averaging, Fourier filtering and proper orthogonal decomposition. The Fourier-method turns out to be the most appropriate for the present purpose. The decomposition is applied to two cases: one with no mean wind and another with moderate mean wind. It is shown that roughly 85% of the vertical flux of the potential temperature and about 72% of the kinetic energy is carried by the structures in the mixed layer in both cases. The corresponding percentage for the potential-temperature variance is 81% in the no mean-wind case and 76% in the moderate mean-wind case. The structures are responsible for as much as 94% of the momentum flux in the mixed layer of the moderate mean-wind case. In the surface layer the background turbulence is generally more important than the structure contribution in both cases. The potential-temperature flux budget is analysed in detail and it is shown that its turbulent transport term is mostly built up by the structures but also the interaction between the structures and the background turbulence plays a significant role. The other important budget terms are shown to be dominated by the structures except the pressure temperature-gradient covariance.