On the intermittency of scalars in atmospheric boundary layer

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The objective of the present study is to characterize the statistics of large scalar fluctuations in turbulent boundary layer driven by atmospheric convection, and contrast the behaviours of active (temperature θ) and passive (humidity q) scalar fields. This issue is assessed by means of a Large Eddy Simulation model for the flow and for the scalar equations, with the subgrid-scale stresses estimated by dynamic modeling [1].
Experimental and numerical studies [2, 3] indicate that, depending on the degree of instability and on surface moisture flux, an entrainment-moistening or drying boundary layer can develop, i.e. humidity, within the mixed layer, may increase or decrease in time.
The current analysis is focused on the high order statistics of the humidity field as compared to the temperature field, in those two regimes. The large scalar fluctuations and intermittency are investigated by evaluating the probability density functions of the scalar (q, θ) increments $\delta_r q = q(x+r) - q(x)$ at inertial range separations, and by computing the cumulated probability of large fluctuations [5, 6]. In agreement with previous numerical findings in convective boundary layer [4], temperature statistics presents saturation of intermittency.
It is now shown that also humidity statistics displays intermittency saturation, with different characteristics depending on the boundary layer regime. In entrainment-moistening boundary layer, humidity displays the same degree of intermittency as temperature, that is an active scalar. In entrainment-drying boundary layer, results obtained for the humidity field, with respect to intermittency saturation, are consistent with 3D experiments [7] and 2D simulations [5] of passive scalar in homogeneous and isotropic turbulence.

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