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Sub-layers inside the entrainment zone of a dry, shear-free convective boundary layer[1] JADE RACHELE GARCIA, JUAN PEDRO MELLADO, Max Planck Institute for Meteorology — The entrainment zone of a dry, shear-free convective boundary layer growing into a homogeneously stably-stratified fluid is studied using direct numerical simulation. Based on the self-similar analysis of the mean and variance buoyancy profiles, we identify two sub-layers within the entrainment zone, defined as the region of negative buoyancy flux: i) an upper sub-layer with a thickness comparable to the penetrative length scale based on the convective velocity and the buoyancy frequency of the free troposphere and ii) a lower sub-layer acting as a transition towards the mixed layer, with a thickness equal to a constant fraction of the boundary layer height. The capping region of the penetrative thermals belongs to the upper sub-layer of the entrainment zone, and the troughs between the penetrating thermals belong to the lower sub-layer of the entrainment zone. Correspondingly, different buoyancy scales are identified in the different regions; parametrizations thereof are provided and explained. This multiplicity of characteristic scales inside the entrainment zone helps to explain the uncertainty associated with previous analysis of entrainment zone properties and the difficulty to parametrize them based on a single length scale and a single buoyancy scale.

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