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Wind-Shear Effects within the Entrainment Zone of Stratocumulus BERNHARD SCHULZ, JUAN PEDRO MELLADO, Max-Planck-Institut for Meteorology — Direct numerical simulations resolving meter and sub-meter scales of the stratocumulus cloud-top are used to investigate the interactions between a vertical shear and convective instabilities driven by evaporative and radiative cooling. Wind shear is found to thicken the entrainment interfacial layer (EIL), to enhance cloud-top cooling, and to increase the entrainment velocity substantially only if the shear velocity Δu exceeds a critical value $(\Delta u)_{\mathrm{crit}}$. We provide an expression for $(\Delta u)_{\mathrm{crit}}$, which is based on two competing processes dominating the inversion dynamics: shear-driven turbulence, and the penetration of in-cloud turbulent convection into the inversion. For typical atmospheric conditions $(\Delta u)_{\mathrm{crit}}$ corresponds to a shear velocity of $1-2\ \mathrm{m\,s^{-1}}$. However, even for $\Delta u > (\Delta u)_{\mathrm{crit}}$ a strong wind shear does not affect in-cloud turbulence as long as the EIL remains thin compared to the cloud layer, i.e. shear effects remain localized within the EIL. Therefore, a strong shear does not necessarily weaken in-cloud turbulence by depleting the cloud, which challenges previous conjectures.

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