Small-Scale Turbulent Mixing at the Top of the Planetary Boundary Layer

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The understanding and the representation of small-scale turbulent mixing in the entrainment zone at the top of the planetary boundary layer remains a challenge. This challenge becomes sometimes quite problematic, like in the case when stratocumulus clouds cap the boundary layer. This seminar will present two examples showing how direct numerical simulation can be used to address part of that challenge. First, in the simpler case of cloud-free conditions, we will see that the entrainment zone can be better described in terms of two length-scales, instead of just one. This result helps explain the observed dependence of entrainment-zone properties on weak- and strong tropospheric stratification regimes. The second example considers the role of evaporative cooling at the stratocumulus top. We will see how mixing enhancement by wind shear can render evaporative cooling as important as other turbulence sources at cloud top. This implication is twofold: evaporative cooling can be relevant in the cloud-top dynamics but only when interacting with other processes (like wind shear), and wind shear needs to be added to the analysis of the stratocumulus-topped boundary layer.