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Vertical profiles of second-order turbulence moments and of the Obukhov length in the stable boundary layer from SABLES98 observations

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The observations of the stable boundary layer (SBL) obtained during the SABLES98 experiment (Cuxart et al., Boundary-Layer Meteorology, 2000, 96, 337-370) are analyzed in order to investigate the vertical variations of the momentum flux T>0, the heat flux Q(<0 in stable condition) and the turbulent kinetic energy E.
The 5-minutes profiles are classified, neglecting the time evolution, in traditional SBL (tSBL, with the momentum and heat fluxes respectively decreasing and increasing with height) and upside-down SBL (uSBL, with momentum flux and turbulent kinetic energy increasing with height). An intermediate class is characterized by nearly constant fluxes (cSBL).
Although tSBL are generally associated to weak and moderate stable stratification and uSBL to moderate and strong stable stratification, it is shown that the classes cover a wide range of Obukhov lengths or of gradient Richardson number, which thus cannot be used as univocal indexes of the vertical structure of the SBL.
The vertical variation scales obtained from the profiles of T, Q and E give indications about the depth of the boundary layer in tSBL cases. For all the cases, the vertical scales are shown to be different for the different statistical moments, and these differences are used to interpret the variability of the vertical profile of the Obukhov length, within the same class.
The use of the surface value as scale for each statistical moment and of the vertical scale of the momentum flux for the height allow a compact description of the tSBL and uSBL structure in terms of turbulence features and of gradient Richardson number trend. For instance, this description shows that typically E changes more slowly than T with height (in tSBL class this means that the turbulent kinetic energy goes to negligible values at larger heights than the momentum flux), and that Richardson number increases with height in tSBL cases, while is almost constant in uSBL cases.