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Analysis of second order moments in the Surface Layer turbulence in an Alpine valley

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Results from the analysis of field measurements in the atmospheric surface layer in the Adige Valley, south to the city of Bolzano/Bozen in the Alps, are presented. Turbulence measurements were performed in July 1999, under various weather conditions, with a sonic anemometer in the middle of the valley floor, in a locally plain and almost horizontal area (down-valley slope everywhere less than 0.2%), rather regularly surrounded by uniformly high apple tree orchards. Special care was devoted to the proper choice of design parameters of the digital recursive filter used to separate turbulent fluctuations from the mean flow, as well as to evaluation of the rotation angles required for streamwise alignment.

The resulting values of various turbulence quantities, such as drag coefficient, displacement height and roughness length, appear similar to those reported in the literature about surface layer turbulence over plain uniform terrain, provided specific features, amenable to the complexity of the valley environment, are identified as such.

As a main result, the analysis of the nondimensional standard deviations (σ_u, σ_v and σ_w) legitimates the adoption, for all the wind components, of the same Monin-Obukhov similarity relationship in the form σ_i/u_*=$\alpha_i(1+\beta_i|\zeta|)^{1/3}(i = u, v$ and $w)$, which was originally proposed only for plain uniform terrain under steady state conditions. This allows to include also the case of winds over a valley floor under slowly varying situations, provided suitable coefficients α_i and β_i are adopted.

It is also shown how the use of more appropriate values of the design parameters for the digital filter, with respect to other choices proposed in the literature, significantly reduce the scatter around the best fit curve.

On the other hand the analysis of temperature fluctuations shows two distinct behaviours of σ_θ/θ_* in the stable and unstable regimes respectively, which are properly reproduced by suitable expressions already proposed in the literature, although with lower values of the coefficients than generally reported for near neutral conditions.

In particular under the latter case a large scatter in the data is observed. However the most scattered data turns out to occur under transition periods (i.e. sunrise and sunset), so that after a specific data selection the best-fit parameters are more accurately estimated.