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Estimation of the wind velocity standard deviations in the suburban and urban surface layer using parameters measured in the roughness sublayer.

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The atmospheric turbulence in the surface layer over urban and suburban areas is affected by the presence of roughness elements. The roughness sublayer (RSL) extends from the ground up to about two to five times the mean building height of the area. Within RSL, turbulence is inhomogeneous and heat and momentum turbulent fluxes are not constant with height, therefore the Monin-Obukhov Similarity Theory (MOST) is not suitable and the surface-layer parameters (friction velocity, stability parameter) are not well defined. Instead, in the inertial sublayer (ISL) above the RSL, the turbulent fluxes are constant and the MOST is still considered valid.

When applying air pollution models for areas where urban sites are present, it can happen to input observed surface-layer parameters that are available from data collected at urban or suburban stations. This means that RSL values are used in the parameterizations of the turbulence variables, such as the wind velocity standard deviations, as they were representative of the ISL, possibly leading to a not appropriate application of the MOST.

We investigate whether it is possible to derive appropriate values of the wind velocity standard deviations in the ISL using RSL observed parameters, through the analysis of sonic anemometer datasets collected in suburban and urban sites.
The ISL wind velocity standard deviation are evaluated as similarity-like analytical functions of the RSL friction velocity and stability parameter. The values derived through the scaling from RSL parameters are then compared to actual observations in the ISL, and they are found to be a reasonable approximation.

To evaluate the applicability of the empirical coefficients of the analytical formulation to other cases, they are estimated from a ‘reference’ experimental dataset, then used and tested for datasets gathered in other experiments.

We also investigate the possibility to derive appropriate estimations of the wind velocity standard deviations in an urban ISL by using measurements collected in the surrounding suburban area.