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Determination of temperature roughness length for complex urban areas with high resolution wireless meteorological stations

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In this study, we determine the scalar roughness for sensible heat in the temperature profile ($z_{0,h}$) based on direct skin temperature measurements and profiles of wind and temperature in a complex urban environment. Classically, skin temperatures are inferred from remotely sensed data (e.g. satellite). However, in complex settings like cities, strong heterogeneities exist in the temperature fields at scales that cannot be resolved by remote sensing. Because they are more precise, in situ measurements, when available, offer a more reliable alternative than remote sensing measurements for measuring temperature. In this study, 91 wireless weather stations are deployed over the campus of the École Polytechnique Fédérale de Lausanne (300 x 450 m), offering high temporal and spatial resolution meteorological measurements from December 2006 to April 2007. The objective here is to calculate the temperature roughness length in order to estimate the sensible heat flux between the ground and the atmospheric surface layer. Calculations are based on the Monin-Obukhov similarity model for temperature in the surface layer. Wind and temperature profiles are measured using a Sound Detection and Ranging System (SODAR) and a Radio Acoustic Sound System (RASS).

To test our approach, we study the dependence of the surface roughness on the wind direction in relation with the campus. Sensitivity analyses of classical surface temperature estimates are also detailed and compared.

Overall, this study illustrates how an extensive network of meteorological measurements can improve our understanding of the land-atmosphere interactions at the smallest scales involved in complex urban environments.