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3D turbulence measurements in inhomogeneous boundary layers with three wind LiDARs

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One of the most challenging tasks in atmospheric anemometry is obtaining reliable turbulence measurements of inhomogeneous boundary layers at heights or in locations where is not possible or convenient to install tower-based measurement systems, e.g. mountainous terrain, cities, wind farms, etc.

Wind LiDARs are being extensively used for the measurement of averaged vertical wind profiles, but they can only successfully accomplish this task under the limiting conditions of flat terrain and horizontally homogeneous flow. Moreover, it has been shown that common scanning strategies introduce large systematic errors in turbulence measurements, regardless of the characteristics of the flow addressed.
From the point of view of research, there exist a variety of techniques and scanning strategies to estimate different turbulence quantities but most of them rely in the combination of raw measurements with atmospheric models. Most of those models are only valid under the assumption of horizontal homogeneity.

The limitations stated above can be overcome by a new triple LiDAR technique which uses simultaneous measurements from three intersecting Doppler wind LiDARs. It allows for the reconstruction of the three-dimensional velocity vector in time as well as local velocity gradients without the need of any turbulence model and with minimal assumptions [EGU2013-9670].

The triple LiDAR technique has been applied to the study of the flow over the campus of EPFL in Lausanne (Switzerland). The results show the potential of the technique for the measurement of turbulence in highly complex boundary layer flows. The technique is particularly useful for micrometeorology and wind engineering studies.