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Turbulence structure of the Urban Boundary Layer over London observed with a Doppler Lidar

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Knowledge of the vertical turbulence structure of the Urban Boundary Layer is of importance in terms of the dispersion of pollutants and for initializing models. Traditionally, one-dimensional spectral and co-spectral measurements in the Atmospheric Boundary Layer (ABL) and therefore turbulence characteristic parameters such as integral time scales of the vertical velocity and fluxes of scalars, Turbulent Kinetic Energy dissipation rate and mixing state of the ABL are resolved from in situ sensors. These observations are either conducted at a few discrete levels from towers within the surface layer, tethered balloons or tall towers in the mixed layer, or aircraft that are not simultaneous in time. Consequently, information about how these parameters vary with height is limited, especially in the UBL. The scope of the present paper is to explore the capability of a Doppler lidar to resolve height dependent spectral and turbulence measurements in the UBL.
Measurements of a HALO Photonics Doppler Lidar conducted in London during 2011 are presented. The instrument was deployed in the frame of the ACTUAL project and was operating in two modes: continuous stare mode (pointing vertically) and b) Doppler Beam Swinging (DBS) mode for measuring the vertical wind profile. Systematic uncertainty analysis based on the integral time scales of the vertical velocity data and implications for the required averaging periods will be presented.
Profiles of statistical vertical velocity moments have been estimated and grouped according to the phase of the ABL development. From vertical velocity variance and corrected aerosol backscatter coefficient profiles, the mixing and aerosol layer heights respectively have been estimated. Mixing and aerosol layer heights were compared with boundary layer heights as obtained from vertical profiles of the wind speed and temperature from aircraft meteorological data relay (AMDAR).
In the frame of case studies the statistical properties and spectral analysis of the vertical velocity and the backscatter coefficient will be studied during entrainment processes, fully developed convection, LLJ development and residual boundary layer.