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Vertical profiles of TKE in suburban, stable, ground-based layer

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Estimation of turbulent kinetic energy (TKE) is very important for atmospheric numerical modeling, since turbulent mixing is often parameterized using TKE. Additionally, turbulence characteristics and consequently, TKE strongly affects distribution of pollutants in atmospheric boundary layer. Thus, it is important to know how TKE is produced, transported and dissipated. Especially, for the stable boundary layer (SBL) it is needed to understand how these processes take place with respect to stability regimes ranging from weak to strong, and at different heights above the surface. In this study we investigate vertical profiles of TKE in the suburban, ground-based layer above the industrial quarter of town Kutina, Croatia during the nighttime, stable conditions. Such situations are generally characterized with intermittent turbulence and conditions favorable for the establishment of pollution episodes.

Three-dimensional wind and sonic temperature were measured at five levels (20, 32, 40, 55 and 62 m above the ground) with the sampling frequency of 20 Hz. Measurements were done by WindMaster ultrasonic anemometers (Gill Instruments). Anemometers were mounted at the 62 m high mast located above the grassy surface. The mast is surrounded by up to about 20 m high trees. The closest trees are found at approximately 20 to 30 m far from the mast.

In order to calculate turbulent quantities it is necessary to select appropriate averaging time interval, over which decomposition into instantaneous mean and random components can be done. In order to do that, two methods were deployed, both based on the Fourier analysis. The first method assumes existence of the energy spectral gap, which is typically found at the mesoscale. The averaging time is taken as the inverse of frequency at which the minimum in the velocity spectrum is found. The second method, which is somewhat subjective, employs the cumulative integral of cospectrum (ogive) of the vertical turbulent momentum flux. The averaging interval is defined as the inverse of frequency at which ogive converges to a constant value.

Based on selected averaging time interval, following turbulent quantities were calculated: TKE, turbulent fluxes of momentum and heat, vertical fluxes of TKE, turbulence dissipation ε, and vertical profiles of above quantities.