EGU21-10105
https://doi.org/10.5194/egusphere-egu21-10105
EGU General Assembly 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Experimental study of the statistical properties of turbulence inside the urban canopy in Moscow

Ilya Drozd[1], Alexander Gavrikov[2], Arseniy Artamonov[3], Artem Pashkin[3], Irina Repina[3,4,5], and Victor Stepanenko[1,4,5]

[1]Lomonosov Moscow State University, Faculty of Geography, Meteorology and Climatology, Moscow, Russian Federation
[2]P.P. Shirshov Institute of Oceanology RAS, Moscow, Russian Federation
[3]A.M. Obukhov Institute of Atmospheric Physics RAS, Moscow, Russian Federation
[4]Lomonosov Moscow State University, Research Computing Center, Moscow, Russian Federation
[5]Moscow Center for Fundamental and Applied Mathematics, Moscow, Russian Federation

Abstract

The statistical characteristics of turbulence inside the urban canopy are analyzed basing on measurements of the eddy covariance tower in Moscow.

The representation of turbulent processes in the urban boundary layer is nowadays a weak point in weather and climate forecast models since no theory describes well the atmospheric boundary layer (ABL) over the surfaces of complex geometry. To contribute to the knowledge of the mechanisms governing turbulent exchange in the complex geometry of the city, the 22-meter eddy covariance tower was installed in the Meteorological Observatory of Moscow State University in 2019. The fluctuations of temperature and three wind speed components were measured using three METEK ultrasonic anemometers at levels 2.2 m, 11.1 m, 18.8 m. We present results based on data obtained from November 2019 to May 2020.

To work with the eddy covariance data, the gap-filling algorithm was developed based on the Gaussian distribution of the variable to be filled before and after the gap, taking into account their covariances. The new method of filling the gaps was compared with linear interpolation and Gaussian distributions neglecting correlation between variables demonstrated fair performance. The three-sigma method was used to filter out spurious peaks.

The data of acoustic measurements were compared with the data from cup anemometers, deployed at similar heights nearby. The main statistical characteristics of the measured series were calculated. Links between turbulent fluxes of heat and momentum with turbulent moments of other orders were obtained. The presence of correlation between the third and second moments in the boundary layer over a complex surface discovered earlier in natural [1] and urban [2] landscapes was tested using the data of the new mast. Variances of the velocity components grow with height within the lowest 10 meters. The daily amplitude of the 20-min temperature variance is proportional to the daily amplitude of the 20-min-averaged temperature. The

proportionality of TKE to the square of the averaged horizontal velocity, which is strictly valid for homogeneous ABLs, was confirmed for a case of complex surface geometry.

The data analysis was supported by the Moscow Center for Fundamental and Applied Mathematics.

References

[1] Barskov K.V., Stepanenko V.M., Repina I.A., Artamonov A.Yu., and Gavrikov A.V. Two regimes of turbulent fluxes above a frozen small lake surrounded by forest. Boundary-Layer Meteorology, 173(3):311–320, 2019. http://dx.doi.org/10.1007/s10546-019-00469-w

[2] Pashkin A. D., Repina I. A., Stepanenko V. M., Bogomolov V. Y., Smirnov S. V., Telminov A. E. An experimental study of atmospheric turbulence characteristics in an urban canyon. IOP Conference Series: Earth and Environmental Science. Vol. 386. No. 1. IOP Publishing, 2019. http://dx.doi.org/10.1088/1755-1315/386/1/012035