On the atmospheric electric field fluctuations at the periods from T=1s to T=100 days

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This paper investigates the background level of atmospheric electric field fluctuations at the periods from T=1s to T=100 days. The data of two electrostatic flux meters (field-mill type) “Boltek-EFM-100”, separated by distance of ~6 km and placed on the buildings of the Institute of Applied Physics and the Institute of Microstructures Physics at Nizhniy Novgorod, were used for the analysis. Continuous records of electric field values and day average temperatures at the ground surface from June 2012 to March 2013 were analyzed. Correlative and spectral analysis methods and also spectral adaptive analysis method were used for data processing.

The measurements of electric field fluctuations in July-August 2013 were made simultaneously with the measurements of the atmospheric turbulence characteristics by the microwave (8 mm wavelength) radiometer.

The basic results are the following:

1. Taking into account the data of the microwave radiometer, two turbulent layers, affecting the electric field fluctuations at the ground surface, have been identified: 1) the near-surface layer (0-300 m) with turbulent inhomogeneities of heavy ions (aeroelectric structures) and 2) the upper layer over the condensation level (~1 km), with turbulent inhomogeneities of electrically charged droplets. Contribution of these layers, including the cases of thunderstorm occurrence, into the electric field fluctuations at the ground surface and statistical signatures of fluctuations were investigated.

2. At the sufficiently large periods 1-100 days the spectral density of electric field fluctuations may be described by the power law with index -0.5; the root-mean-square deviation (in the large frequency band) is ~40% from the average E-field value. A smooth frequency dependence of field fluctuations spectral density is analogous to the frequency dependence of atmospheric turbulence spectral density, for which the respective structure function reaches saturation at these time intervals.

3. There is no strong direct correlation between flux meters data and temperature. Spectral density of temperature fluctuations falls down by power law with index -1.7 (~5/3), i.e. more quickly, than for electric field fluctuations. At the same time, in some narrow bands the quasi-periodic correlated disturbances of E and T exist, which are evidently related to characteristic times of air mass transportation and which independently affect on the both parameters analyzed.