

# ELECTRIC FIELD AND ELECTRIC CURRENT MEASUREMENTS IN THE LOWER ATMOSPHERE

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## ABSTRACT

The methods for aeroelectrical measurements are reviewed. The lower atmosphere is considered as a weakly ionized, turbulent medium. The electrostatic fluxmeter (field mill) is substantiated for precise observatory measurements of the atmospheric electric field. The electrostatic induction sensors are used for observations of short-period pulsations in the frequency band 0.001–1 Hz. The using of current collector is proved for measuring the vertical electric current in the atmosphere. The transfer functions of the sensors are analyzed.

## INTRODUCTION

Recent knowledge of solar-terrestrial relations has brought an essentially new approach to the study of aero-electrical processes in the Earth's environment. The global electrical circuit, according to its classical definition, represents the current contour formed by the bottom ionosphere and terrestrial surface conducting layers, with thunderstorm generators as the basic electrical sources, and the areas of a free atmosphere as the zones of returnable currents. The global electrical circuit has the properties determined by the physical parameters of the magnetosphere, ionosphere, atmosphere and lithosphere. Atmospheric electricity is an integral part of the Earth's electromagnetic environment. An extensive database, which was obtained after long-term ground-based aero-electrical measurements, is a background for experimental research of the role of the global electrical circuit in the solar-terrestrial relations. In particular, the database of the mid-latitude Geophysical Observatory "Borok" (<http://geobrk.adm.yar.ru:1352>) contributes substantially to the study of the Earth's electromagnetic environment [1].

## EXPERIMENTAL TECHNIQUE AND RESULTS

There are several ways one can measure the electric field in the lower atmosphere, which is a weakly ionized, turbulent medium. A simple method is to connect an electrometric, high resistance amplifier to the antenna and to measure the electrostatic potential of atmosphere at the point of antenna's position. Sometimes, the ion-producing radioactive alpha-particle source is mounted at the tip of antenna for increasing the electric conductivity of the surrounding air. For precise observatory measurements of the atmospheric electric field, an electrostatic generator (field mill) is often used

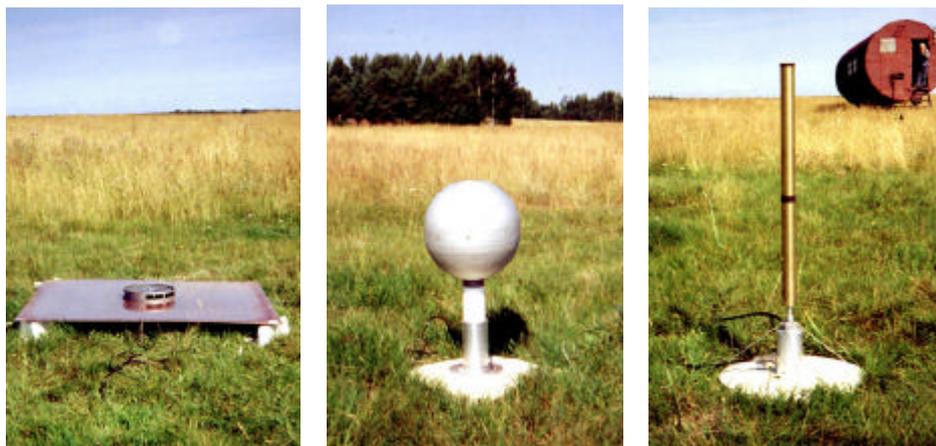


Fig. 1. Electrostatic fluxmeter and electrostatic induction sensors.

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as a sensor (Fig.1). The field mill is a device based on electrostatic induction. A quasi-static electric field is transformed into AC signals by means of periodic screening/unscreening of the sensor-based electrodes during rotation of the grounded plate. The field mill construction enables increasing of sensitivity by a differential method of the measurement. Usually, for calibration of the device a calibrating plate is used, which is mounted at a fixed distance from sensor-based electrodes.

One of key problems in studies of atmosphere electrical phenomena nowadays is the analysis of spectra of aero-electrical pulsations [2]. The electrostatic induction sensors are used for observation of short-period pulsations in the frequency band 0.001–1 Hz. In this case the sensor contains an antenna of cylindrical or spherical form (Fig. 1) and an operational preamplifier. The transfer function of the sensor is  $K(f) = h_e / (1 + C_a / C_i)$ , where  $h_e$  is the effecting height,  $C_a$  – the sensor capacity,  $C_i$  – the input capacity of the amplifier.

Many different sensors are used for measuring the vertical electric current in the atmosphere [3]. Generally used sensors are the Wilson plate, the horizontal long-wire antenna, the passive pair-hemisphere antenna of Burke-Few type. In the course of development of the horizontal long-wire antenna method, the vertical current in the atmosphere surface layer is recently measured with the method of voltage difference at a given stable resistor, connecting the sensor with the ground. The value of its resistance is much less than the internal resistance of the surrounding atmosphere. The device comprises a current-collecting sensor, a preamplifier and a block of band-pass filters. The effecting collecting area of the horizontal current collector is  $S_d = 2\pi LH / \ln(2H / r_0)$ , where  $H$  is its geometric height,  $L$  – the length of antenna,  $r_0$  – the wire radius. The example of electric current and electric field variation under different meteorological conditions is shown in Fig. 2.

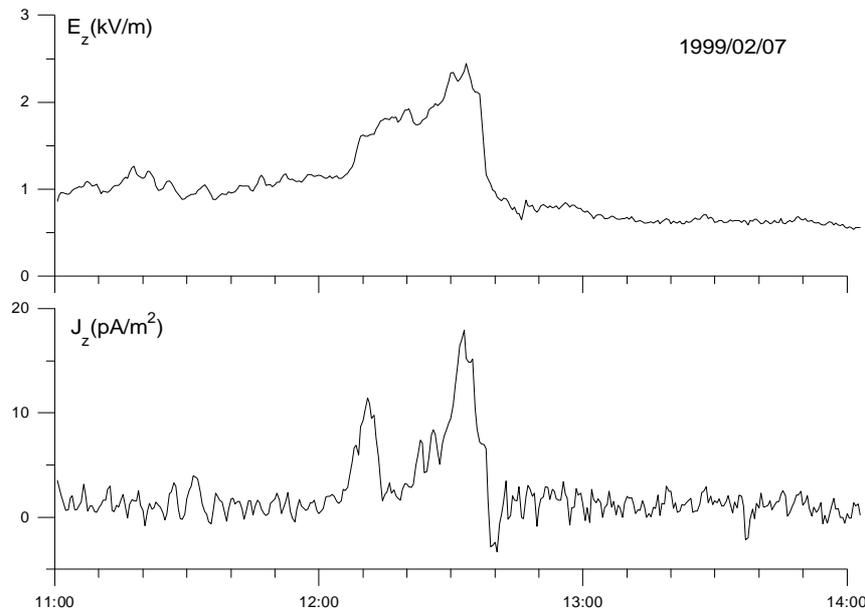


Fig. 2. Plot of the vertical aero-electric field and current variations.

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