Positive anomalies of the quasistatic electrical field in the near ground atmosphere and volcanic activity

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ABSTRACT: The positive anomalies of a gradient potential of an electrical field in the near ground air in conditions of good weather are investigated. It is shown, that ashes emissions of volcanos can result to such anomalies even in a case of neutral electrical particles. It is assumed, that the positive anomalies of an electrical field on Kamchatka are connected with the activity of volcanos. Such positive anomaly in an electrical field intensity was observed on December 2 2007 and is connected with the presence of aerosols, that proves to be true by fall of air electroconductivity value. At this time there was an eruption of Shiveluch volcano. The easy aerosols of this eruption could reach the area of geophysical observatory Paratunka. Similar anomalies with the same attributes were observed and in other days, when there were eruptions of volcanos.

The Earth electric field intensity in the near ground atmosphere is affected by many factors of global and local character. In fair weather conditions a typical curve, so called unitary variation, is simultaneously observed over the whole globe during minimum effect of local factors. Disturbances caused by local convective generators which are changed depending on a season are imposed on unitary variation. Anomalies, interpreted as a sharp change of electric field intensity in fair weather conditions during air undisturbed thermodynamic state, require thorough investigation. Negative anomalies were considered by the author for the period from 1997 to 2002 and were associated with natural ionizer effect [Smirnov, 2005]. Positive anomalies are more difficult to be methodically detected and are weakly investigated. Such a positive anomaly in electric field intensity was observed on December 6, 2006 at “Paratunka” observatory in fair weather conditions [Fig. 1a].

“Paratunka” observatory ($52^0$58,33' N, $158^0$15,02' E) is located in the South of Kamchatka peninsular to the West from the Avacha Bay. Measurements were carried out by “Pole-2” and “Elektroprovodnost-2” sensors constructed in a Branch of Voeikov Main Geophysical Observatory, by Research Center of Remote Atmosphere Sounding.

In fair weather conditions a current flows through the atmosphere, it has $j=\lambda E$ conductivity, where λ — air electroconductivity, E — electric field intensity. Hence, the relation of field intensity and electroconductivity is the following:

$$E \sim 1/\lambda \qquad (1)$$

Electroconductivity is related to light ion mobility (u) and concentration (n) in the formula:

$$\lambda = e(n_- u_- + n_+ u_+) \qquad (2)$$

Ionization-recombinational equation for light particles has is the following [Imyanitov and Shifrin, 1962]:

$$dn_+/dt = I - \alpha n_+ n_- - \beta n_+ N_- - \gamma n_+ N_0 \qquad (3)$$

where N_- —negatively charged heavy ion concentration, N_0 — neutral particle concentration, α,β,γ — corresponding recombination coefficients, I — ionization intensity. Analogous equations may be written for n_-, N_-, N_+, and N_0. In stationary state and in still air $dn_+/dt = 0$. Thus:

$$n_+ = I/(\alpha n_- + \beta N_- + \gamma N_0) \qquad (4)$$

It may be noted that $\beta N_- + \gamma N_0 >> \alpha n_-$ and $\beta \approx \gamma$. Let's represent $N_- + N_0 = N$. Acting on the premise that roughly $n_+ = n_-$ and $u_+ = u_-$ the dependence of electroconductivity on heavy impurity concentration is estimated as follows:

$$\lambda \sim 1/N \qquad (5)$$

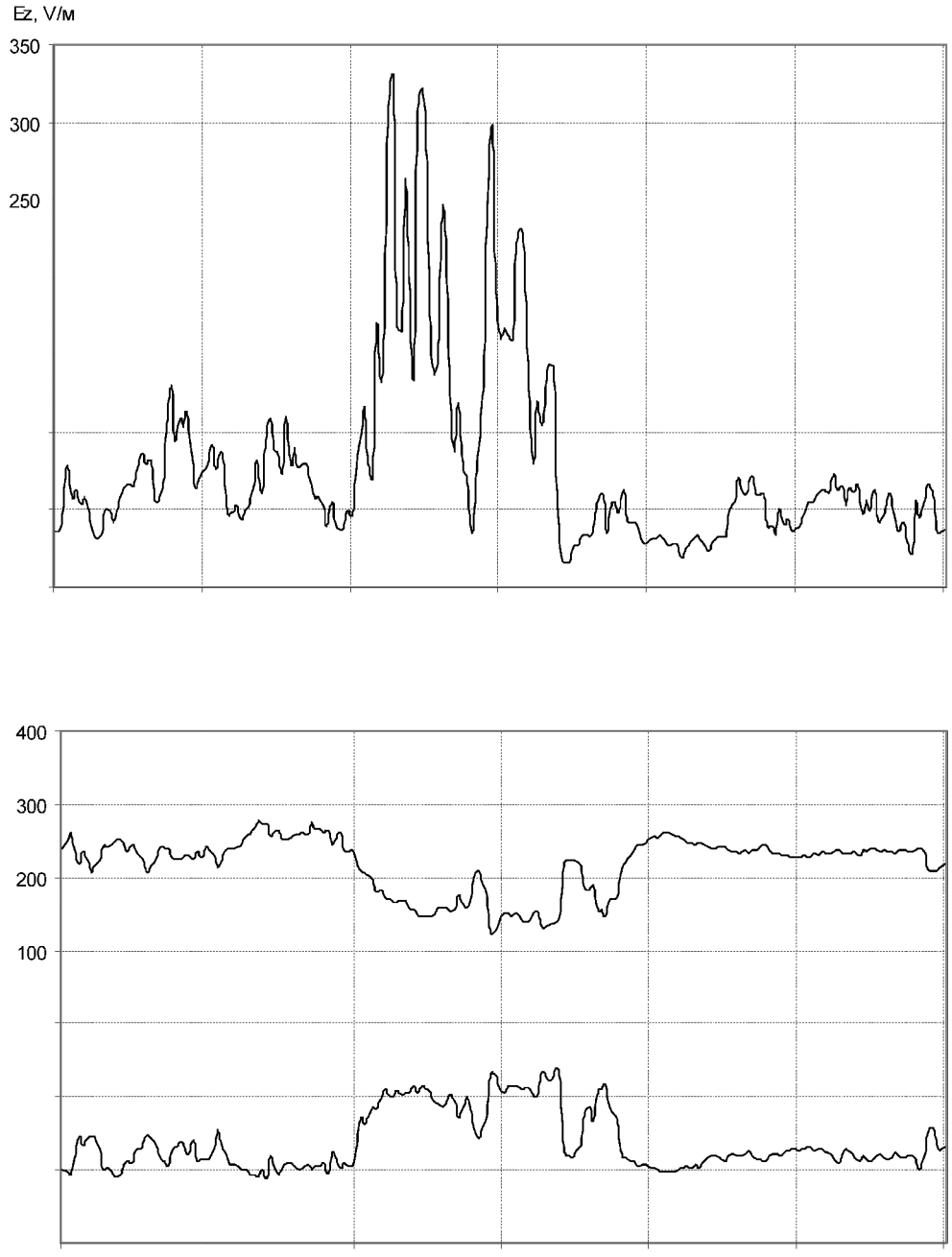

Fig. 1 Graph of potential gradient of electric field intensity (a) and air electroconductivity caused by positive and negative ions (b) in the near ground atmosphere in reference units.

Electroconductivity pattern caused by positive and negative ions during the anomaly are shown in Fig.1b. From the formulas (1) and (5) the positive anomaly development may be presented as follows: heavy impurity appear in the air which causes electroconductivity modulus decrease; and electroconductivity modules decrease causes field intensity increase that is illustrated in Fig.1.

Air electroconductivity modulus value decrease could be explained by the decrease of radioactive material emanation associated with atmospheric pressure fall. But atmospheric pressure for the period was not accompanied by considerable variations (Fig. 2). There was no any effect “blocking” radioactive gas emanation at this time.

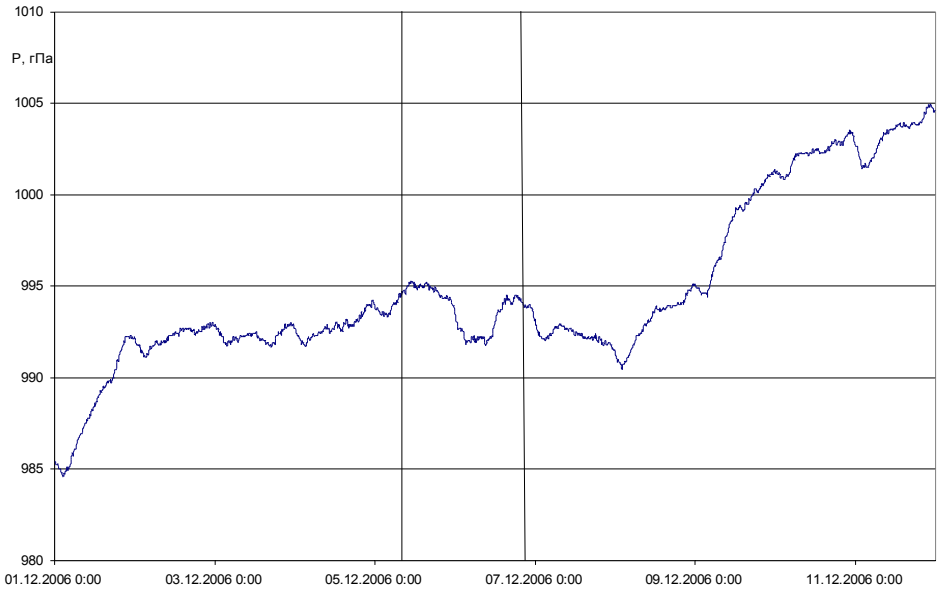

Fig. 2 Graph of atmospheric pressure. Vertical lines indicate the time interval of figure 1.

One may suppose that atmospheric impurity could appear in connection with Shiveluch volcano eruption (56°39' N, 161°21' E) which became active at that time. A similar anomaly with the same features was observed on December 3, 2007 (Fig. 3). According to KVERT data [Girina et.al., 2007] vulcanian-plosive eruption of Shiveluch volcano took place at that time. On the cone gas-ash castings and burning hot avalanche failures with ash ascent up to the height of 5.3 km above the sea level and also weak burning hot avalanches occurred according to seismic data. Aerosols from this eruption could reach “Paratunka” geophysical observatory region and cause positive anomaly of electric field intensity in the near ground layer of the air.

The applied technique allows us to detect anomalies with 6-16 hour duration. Longer anomalies are more difficult to be detected at the background of daily variation. Moreover, anomalies from stronger eruptions could be shielded by meteofactor effects.

The method of detection of impurity in the near ground air using continuous observation of quasi-static electric field intensity may be applies for monitoring of atmosphere ecological state.

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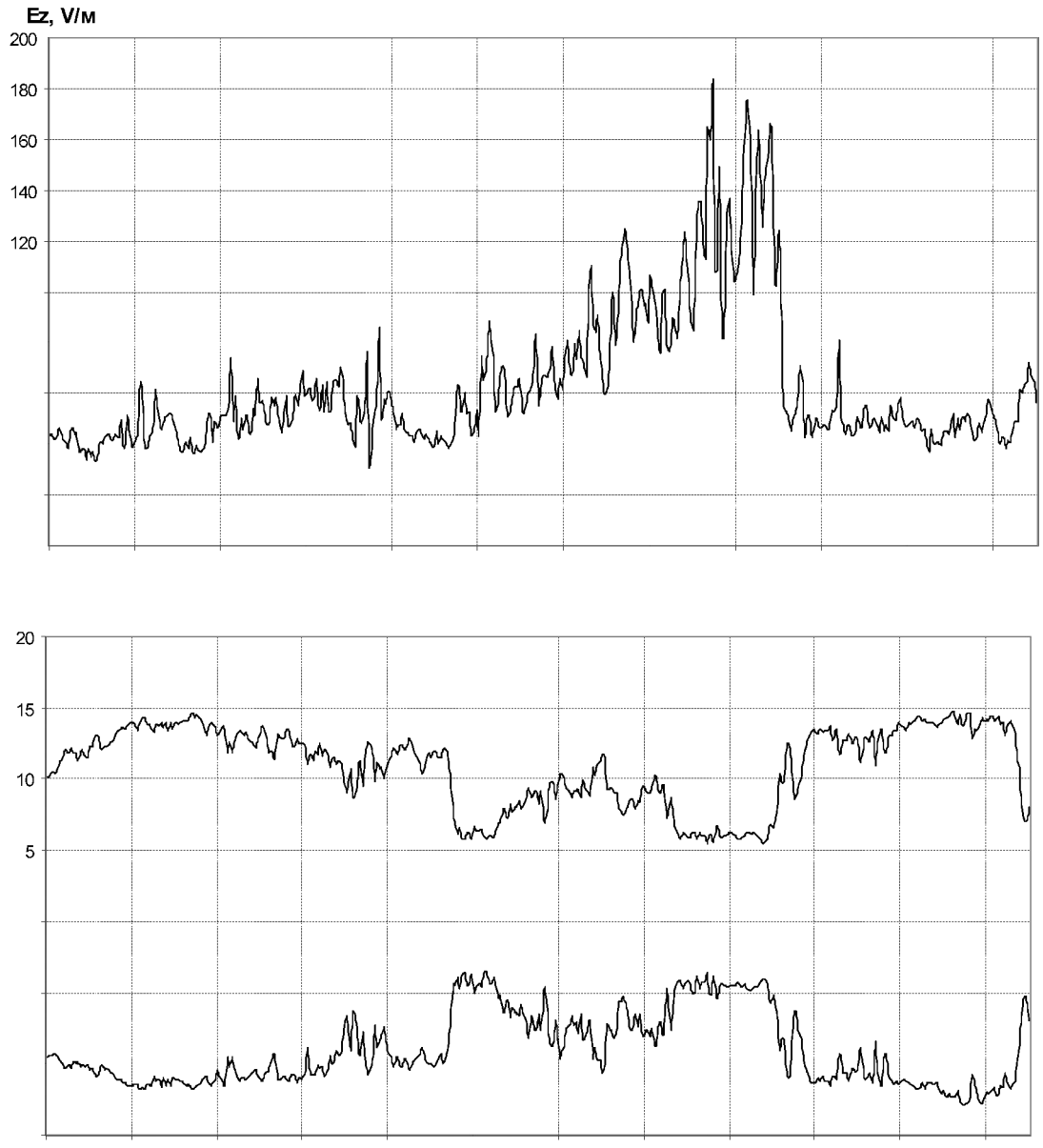

Fig. 3 Graph of potential gradient of electric field intensity (a) and air electroconductivity caused by positive and negative ions (b) in the near ground atmosphere in reference units.