A new approach to the global electric circuit conception

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For a long time we have tried to find the definite Space parameters which could properly describe their influence on the Earth. Such parameters like density and velocity of the solar wind as well as the components of the interplanetary magnetic field (IMF) Bz and By were used in our statistical studies. As a rule we got not very high coefficients of correlation between the space and atmospheric parameters.

Finally we took such space parameter as the solar wind dynamic pressure. It is known that the solar wind dynamic pressure together with IMF component Bz determines subsolar distance between the Earth and magnetopause of the magnetosphere. Furthermore we used the subsolar magnetopause position (expressed in the Earth radius units) as a main parameter in our studies. It turned out that a position of the magnetopause determines the physical processes in different spheres of the near-Earth space.

It was found that the values of critical frequency of ionospheric region F2 at some polar stations during noon of wintertime depend on the correspondent positions of the magnetopause [1]. The coefficients of correlation between these two parameters are very high (more than 80 percents) for different stations in Arctica and Antarctica. The electron density decreases with approaching of the magnetopause more closely to the Earth.

Figure 1 shows how the stratosphere and troposphere temperatures measured by the atmosphere balloons vary with the magnetopause position changes. Once again the meteorological parameters were taken for noontime of the same season in order to minimize influence of the solar ultra violet radiation. Atmospheric temperature is shown along the X-axis, while magnetopause position - along the Y-axis. One can see that the coefficient of correlation between these parameters for altitudes 20-28 km exceeds 80 %, while the coefficients of correlation decrease at other altitudes.

This Figure shows the data for Achangelsk (geographical latitude 64^{o}N). Similar dependence was obtained for other stations (for example, for Murmansk whose geographical latitude is 69^{o}N, and also for Petrozavodsk-61.4^{o}N). In all presented cases the stratospheric temperatures (altitudes 20-28 km) increases with approaching of magnetopause more closely to the Earth.

We attract your attention to strong coupling between the magnetopause position and the magnitudes of atmospheric electric field measured by the atmospheric balloons above South Pole Station in Antarctica. These data were provided to us by Dr. Bering and are shown at Figure 2. Correlation coefficient is also high in this case - 0.78. Statistical significance (for 95% confidence level) of these relations was checked by means of the Student t- distribution test (the thin vertical lines at the Figure show confidence interval). It is evident that almost all observation points are located within this confidence level. So statistical significance of our studies is very high. The magnitude of electric field in atmosphere is proportional to the nearness of magnetopause to the Earth.

We consider the latter result as very important. Close connection between the magnetopause position and magnitude of the atmospheric electric field allowed us to use concept of the global electric circuit as a physical mechanism for explanation of the obtained results.

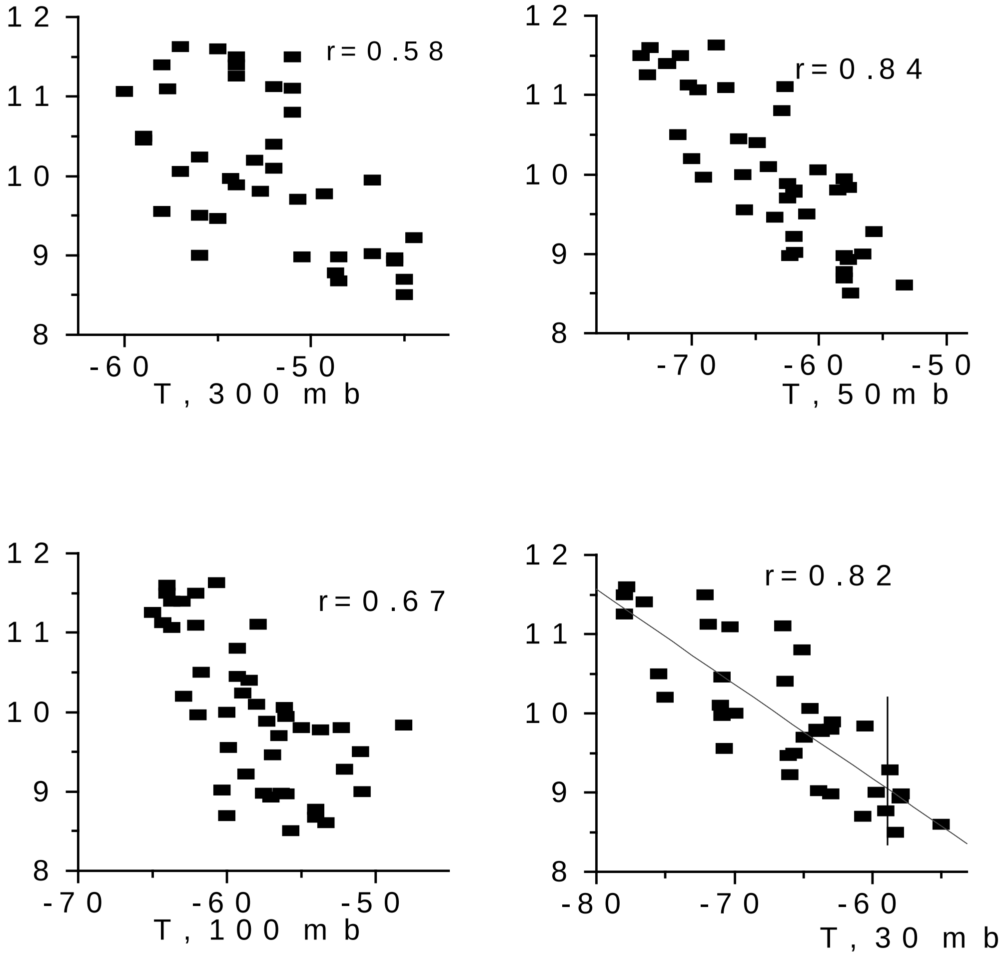

Figure 1. Dependence of the daytime temperature variations above Archangelsk (64.60 N; 40.50 E) at different isobaric surfaces on the magnetopause subsolar position during period of 03.10.1988-25.12.1988.

We propose a modification of the previous global electric circuit configuration by placing its external element on the magnetopause and including the Electro- Motive Force generator (EMF) driven by the solar wind. In this configuration a previous global electric circuit will be a part of a new, more complicated circuit which is controlled by two sources of energy. A scheme of a revised global electric circuit is presented in the next Figure 3: where ε_1 is external generator; ε_2 is troposphere generator. The passive elements of this circuit are the ionosphere (Ri) and stratosphere (Rs) resistances.

There are two layers where enhanced density of the charged particles exists (they are the ionosphere and stratosphere, respectively) and consequently, conductivity of these layers is high. It is proved by many previous measurements. Besides that the circuit includes also Re- resistance of the ground surface, which has different but high conductivity except the breaks between the tectonic plates.

Under normal circumstances a current could not flow through the lower troposphere. However, the troposphere is saturated by water vapors, which could be polarized (dielectric constant of water is 80 F/m). High polarization of water vapors together with the intense vertical up-going flows of air could be two necessary

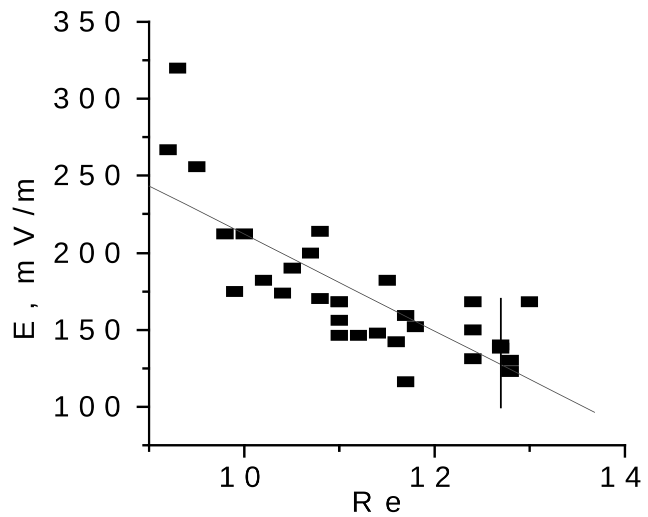

Figure 2. Dependence of the atmospheric electric field values measured above South Pole Station (Antarctica) on the subsolar distance Re between the Earth and the magnetopause.

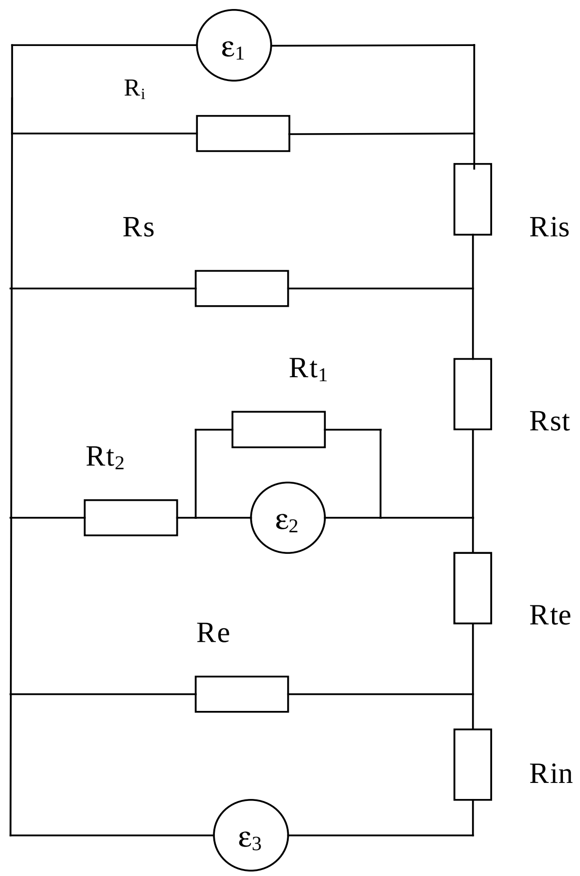

Figure 3. A scheme of a modified global electric circuit. See the explanations in the text.

conditions to increase atmospheric electric field in troposphere. Similar conditions exist inside the clouds where the vertical up-going air flow is intense. In this case a current of global electric circuit will get a chance to flow through troposphere and to supply additional power to the troposphere generator ε_{2}.

The main peculiarities of this scheme are the following:

1. There is an external main source of energy, driven by the solar wind energy.
2. Total current in the circuit will be a sum of the currents in each conducting layer.
3. Both generators could operate in the regimes of a current generator or a voltage generator. It will depend on a value of ratio of the load resistance and internal resistance of a generator.

Our opinion is that this version of the global electric circuit can explain many presented phenomena. The decreases of electron density can be explained as result of the ionosphere heating by electric current when ratio O/N2 decreases and the coefficient of recombination is increasing.

The increasing of temperature of middle atmosphere is a result of atmosphere heating by elecrtric current. Our preliminary numerical estimations show that under typical atmospheric conditions the Joule heating of the stratosphere by the current is comparable with rate of heating by the Sun ultra violet radiation in the ozone layer.

Besides that the circuit includes Re resistance of the ground surface, which depends on the character of the lithosphere (salt or fresh water, rocks, sand etc.) Conductivity of this layer decreases sharply in the breaks between the tectonic plates. If the current flows through the breaks between the tectonic plates the polarization electric charges will be accumulated at the boundaries of these plates. Polarization fields could produce an additional kinetic momentum for plates. When the internal tectonic activity is high enough in some region additional kinetic momentum will be energy impulse triggering an earthquake occurrence.

Of course the proposed scheme is a simplified version of a real circuit. It seems that this version of the global electric circuit could include some additional EMF generator located deeply in the litosphere in order to explain some experimental results, which we obtained. Also this version of global electric circuit does not include inductive and capacitive components and ignores time variability of its parameters. It is a goal of the future studies.

Reference

1. Makarova, L.N., Shirochkov, A.V., and Koptjaeva, K.V. The Earth's magnetopause as an element of the global electric circuit. Geomagnetism and Aeronomy, 1998, v.38, #3, 156-159 (in Russian).