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The ionospheric electric field variations caused by the release of radon from the ground

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Due to the increase in radon emanation, the conductivity in the surface air layer increases, which causes a variation of the electric field not only in the lower part of the atmosphere, but also in the ionosphere. There are known proposals to use such ionospheric disturbances as precursors of earthquakes.

We calculate ionospheric electric fields within the framework of a quasi-stationary model of the atmospheric conductor that includes the ionosphere. The conductivity tensor in the ionosphere is a gyrotropic tensor. In the atmosphere below 50 km, it becomes a scalar. The height profile of the conductivity is constructed in [1] as some average of known empirical models. Above 65 km (E- and F-layers of the ionosphere) during the day (or 90 km at night), our conductivity model is based on empirical models IRI-2016, MSIS 1990 E, IGRF.

Since local phenomena are considered, we neglect the curvature of the Earth's surface. The average potential value in the ionosphere we set equal to zero. Conjugate ionosphere is taken into account. We consider the Earth's surface to be equipotential, since the conductivity of soil and many minerals is many orders of magnitude greater than the conductivity of air. We determine the voltage between the ground and the ionosphere V_0=245 kV, basing on the fair-weather current density j_0=2 pA/m^2, which is typical for the Global electric circuit (GEC).

With an increase in air conductivity in the radon emanation region, the current from the ionosphere to the ground through this region increases. As a rule, radon does not rise above 1.5 km during the day. We consider an increase in conductivity thirty times in the region containing radon.

Above such a disk we apply the numerical method, based on the decomposition of the solution into a Fourier series in horizontal coordinates. In the lower atmosphere the conductivity is scalar, which greatly simplifies the solution. The availability of different effective methods for the two parts of the computational domain makes it advisable to use the domain decomposition method.

The calculations performed showed that even with extreme radon emanation in the disks with different radii of 10-100 km and height about 1 km, the electric field disturbances in the E- and F-layers of the ionosphere are several orders of magnitude smaller than the supposed precursors of earthquakes, and then the fields usually created there by other generators. These results confirm the conclusions of the papers [2, 3], in which some simplifications of the electrical current continuity problem were used.

The D-region is fundamentally different in that in it the fair-weather electric field makes the main contribution to the vertical component of the field. It is shown that this component of the field can double over the area of intense radon emanation compared to the fair-weather field. There is a hypothesis that the field-aligned component of the electric field strength significantly affects the formation of the D-region, for example, causes lifting of the lower boundary of the D-region [4]. Such a lifting, as well as other variations in the parameters of the D-region, as precursors of an earthquake, could be detected using remote sensing [5].

References

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