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Theoretical models of atmospheric and ionospheric anomalies that can be interpreted as earthquake precursors

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The report provides a critical analysis of some modern theoretical models and hypotheses explaining the origin of atmospheric and ionospheric precursors of earthquakes. One of the most noticeable phenomena is the bay-like variations of the near-surface atmospheric electric field (AEF) with an amplitude of about 100 V/m. These phenomena were sometimes observed before strong earthquakes under fair weather condition. In early theoretical studies, it was assumed that such variations were caused by so-called mechanoelectric transducers located in the earth's crust. In more recent studies, abnormal changes in the electrical conductivity of the near-surface atmospheric layer and an increase in radon emissions from the soil were considered as possible causes of these phenomena. However, theoretical estimates have shown that all these models predict variations in near-surface AEF that are much smaller than the observed values. The analysis shows that another mechanism is more effective [1]. The observed AEF anomalies can be due to the vertical circulation of weak air flows, which carry away charged aerosols, light and heavy ions thereby producing space charge re-distribution in the atmosphere. Such a mechanism makes it possible to explain large variations in the vertical AEF up to changing the sign of the field to the opposite. However, the connection of this mechanism with earthquakes remains hypothetical.

The transport of aerosols and other charged particles, which are carried away by turbulent flows of air masses, can lead to the formation of vertical seismogenic currents in the atmosphere, which are carried by these charged particles. The electric fields excited by seismogenic currents in the ionosphere are studied in the report on the basis of a generalized model of such currents. The theory predicts that ionospheric perturbations generated by seismogenic currents are insignificant regardless of the nature of these currents and they are unlikely to explain the amplitude ionospheric earthquake precursors.

An increase in radon gas emissions from the soil was observed in seismically active areas prior to some earthquakes. Additional ionization of the air due to the radioactive decay of radon nuclei can lead both to an increase in the electrical conductivity of the near-surface atmospheric layer and to a change in the fair weather atmospheric electric current. There is a hypothesis that this effect can cause variations in the total electron content and currents in the ionosphere.

Another hypothesis suggests that an increase in radon emission is accompanied by heating of the lower layers of the atmosphere due to the release of latent heat during condensation of water vapor on light ions and ion clusters resulted from the radon nuclei decay. Theoretical analysis shows that both of these effects are insignificant and therefore cannot affect the ionosphere.

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References

[1] V.V. Surkov, Phys. Earth 2 (2024) 3.