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Possible physical explanation and modeling of the ionospheric perturbations observed before earthquakes

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It has been proposed that earthquakes are preceded by electromagnetic signals detectable from ground- and space-based measurements. Ionospheric anomalies, such as variations in the electron density a few days before earthquakes, are one of the precursory signals proposed. Since Global Positioning System (GPS) data can be used to measure the ionospheric total electron content (TEC), the technique has received attention as a potential tool to detect ionospheric perturbations related to earthquakes. In that way the anomalous ionosphere modification before some strong earthquakes of different Earth regions has been found out with using GPS TEC measurements in the recent years.

We consider that the very probable reason of the observed NmF2 and TEC disturbances observed before the earthquakes is the vertical drift of the F2-region ionospheric plasma under the influence of zonal electric field of seismogenic origin. To check this hypothesis, the model calculations were carried out with use of the UAM (Upper Atmosphere Model) - the global numerical model of the Earth's upper atmosphere. The upper atmosphere state, presumably foregone a strong earthquake, was modeled by means of switching-on of additional sources of the electric field in the UAM electric potential equation which was solved numerically jointly with all other UAM equations (continuity, momentum and heat balance) for neutral and ionized gases.

In the given work we present model calculations done for several variants of spatial

configuration of electric field potentials. The sources were set in the form of additional positive and negative potentials on the western and eastern boundaries of near-epicentral areas (dipole configuration) and different configurations of positive potentials over whole near-epicentral area. These sources were switched on and maintained as permanent during several days. The calculated ionospheric effects in TEC and foF2 (F2-layer critical frequency) created by additional sources of the electric field in mid-latitudinal and equatorial regions were analyzed.

Results of the model calculations have revealed a fine agreement with GPS TEC anomalies observed before strong earthquakes in the middle and low latitudes both in spatial scales and in amplitude characteristics.