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Transient geomagnetic effect caused by 1908 Tunguska event

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Abstract

The results of estimates of magnetic field generated by current systems in the E-layer of ionosphere disturbed by atmospheric oscillations after Tunguska explosion are presented.

1. Introduction

The analysis of the magnetograms of Irkutsk observatory on the 30th June 1908 showed that the explosion of Tunguska bolide was accompanied by variations of the Earth's magnetic field, which were being continued for several hours [1]. Irkutsk geophysical observatory is located approximately in 950 km to the southeast from the point of Tunguska explosion and it was nearest point, where the continuous recording of the components of the geomagnetic field was in progress. The similar records obtained by Sverdlovsk and Tbilisi observatories don't point out any variations, which could be associated with Tunguska event. Previously the geomagnetic effect has been explained by the distortion of the regular current system in the E- layer of the ionosphere, accountable for Sq -variations of the geomagnetic field [2]. We suppose that it was caused by magnetic field of the current system, generated in the E-layer of ionosphere by gas dynamical flow after the Tunguska explosion.

2. Atmospheric oscillations

Present - day views on the gas dynamical flow, which develops at the time of the flight of meteoroid through the atmosphere and its subsequent explosion, make it possible to explain both the formation of the region of the increased ionization in E- layer and comparatively rapid - for several minutes - the transfer of the excited region throw 950 km.

Plunging through the atmosphere, cosmic body forms a hot rarefied channel behind it, the hydrostatic equilibrium of pressure in the channel becomes broken [3, 4]. The particles of the body vapor and atmospheric air, involved in the motion, lift along this channel upward (so-called plume). In the rarefied layers of the atmosphere they move along the ballistic trajectories in the gravitational field. While falling down gas loses its kinetic energy in dense layers of the atmosphere, which is converted into thermal energy. Then the reflected shock wave is formed. The gas heated in it rises up and all these processes repeat, formation and propagation of acoustic-gravitational waves is initiated. The effects of heating and ionization of gas at height of 100 km, caused by the oscillations in the atmosphere, can lead to a distortion of the existing current system [5] in ionosphere and generation of new ones. Since the Tunguska body had an oblique trajectory, the plume was ejected in the direction opposite to motion of Tunguska body and provided ionized region at the distance 700 km from the epicenter at time moment 400 seconds after explosion. Gas dynamic parameters in the plume have been calculated in accordance with [3]. The temperatures obtained don't contradict to those presented by Shuvalov and Artemieva [6].

3. Current system

In the E-layer of the Earth's ionosphere disturbed by the gas dynamical plume electric field is generated by Lorenz force while plasma moves across the Earth's magnetic field. Gas dynamical simulation and estimates of the plume parameters have been fulfilled to calculate conductivity profiles and the electric field. Magnetic field of the induced current system has been obtained by the numerical simulation of Maxwell's equations.

Analysis of calculation results of this current system shows that an unique azimuth of trajectory of the

body exists, for which the variations of all three components of the geomagnetic field do not contradict to the observation data. This azimuth is equal to 306 degrees, while other estimates are in the range of 290-344 degrees.

In Figures 1 and 2 the calculated variations of vertical and horizontal components of the geomagnetic field on the Earth's surface, superimposed on the map of Irkutsk region are shown.

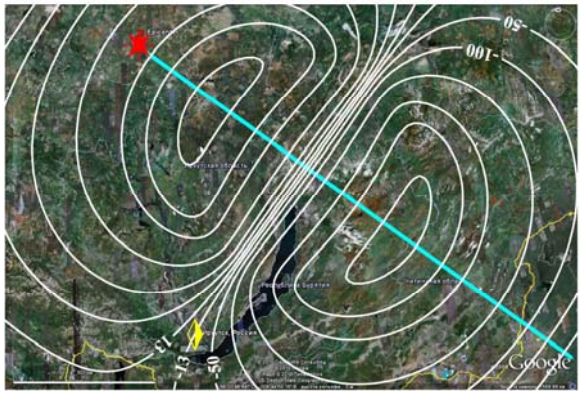

Figure 1: Vertical component variations of the geomagnetic field (in nT) .

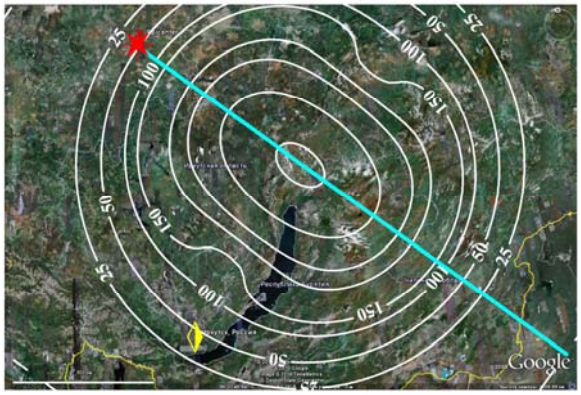

Figure 1: Horizontal component variations of the geomagnetic field (in nT).

4. Summary and Conclusions

This idea of the atmospheric plume ejected along the trajectory and ionization in the upper atmosphere, caused by the following atmospheric oscillations, could explain the geomagnetic effect both in general and locally in Irkutsk observatory: the time delay and the variations of all magnetic field components. Binding of simulation results of observation data also allows us to select the unique trajectory azimuth for Tunguska body.

References

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