SIMULATIONS OF THE GEOMAGNETIC FIELD DISTURBANCES CAUSED BY THE TUNGUSKA EVENT 1908. M. Yu. Kuzmicheva[1] and T. V. Losseva[2], [1]Institute of Geospheres Dynamics RAS, (Leninsky prospect 38, bld. 1, 119334 Moscow, Russia, kuzm@idg.chph.ras.ru), [2]Institute of Geospheres Dynamics RAS (Leninsky prospect 38, bld. 1, 119334 Moscow, Russia, losseva@idg.chph.ras.ru).

Introduction: On the 30 of June 1908 the fall of a big meteoroid caused explosion in the atmosphere and vast devastation on the ground. The epicenter of the explosion was located at 61° n al and 102°e l close to the Podkamennaya Tunguska river, so the event was named the Tunguska bolide.

After the Tunguska event perturbations of components of the geomagnetic field were detected by the Irkuts's geophysical observatory. This geomagnetic effect was found out only in the Fifties [1], when processes in the ionosphere had been understood better.

The geomagnetic field disturbances, detected in Irkutsk started several minutes after the Tunguska explosion. The Irkutsk's geophysical observatory itself is located at a distance of almost 1000 km from the epicenter. Origin of local disturbances of the geomagnetic field after the Tunguska event was explained by increased ionization in the E-layer of the ionosphere [1]. Further study of gas dynamics flows in atmospheres in catastrophic events (simulations of the fall Schumaker-Levy-9 comet onto the Jupiter in 1994 [2]) showed that generation of gas plume due to explosion heads to large-scale disturbances in the upper atmosphere. Plume, throwing up and then falling down provides increased ionization and its transport [3]. Simulations of gas dynamical flow of the Tunguska event were realized in [4], [5]. Hereafter simulations of conductivities in the atmosphere, disturbed by the plume, electric current systems, induced by its motion and the currents' magnetic field have been carried out. Based on the proposed model we have managed to explain some of the observational data, obtained in Irkutsk in 1908, and determine azimuth of the trajectory of the Tunguska meteoroid by independent manner which value is in a good agreement with azimuths obtained by others (reviewed in [6])

Atmospheric oscillations: A meteoroid entering the atmosphere forms the hot rarefied channel behind, in which the hydrostatic pressure equilibrium is violated. The gas rushes through this channel up and then moves along ballistic trajectories in the rarefied upper atmosphere. The particles involved in the uplift motion are decelerated, and then the gas plume falls down from the height. Impinging dense layers of the atmosphere the plume gas compresses, its kinetic energy is converted into heat. The hot gas expands, and the scenario repeats. Thus, the bulk of the ejected plume involves into the complex oscillatory motion with a period depending on a height of ejection. Rising up higher 100 km, the mass particles of the plume move ballistically, so a horizontal component of their velocities remains unchanged. A bottom of the hot portion of the plume is capable to give input into increased ionization in the ionosphere. As was shown by gas dynamical simulate ions these gas particles have got ejected from heights of 15-20 km, so they have almost the same horizontal component of speed, when plume is in the rarified upper atmosphere. After fall down and flattening it starts decelerating in horizontal direction. In fig.1 temporal evolution of the plume particles ejected from different heights (the upper panel) and temperature evolution at different heights (the lower panel) are shown.

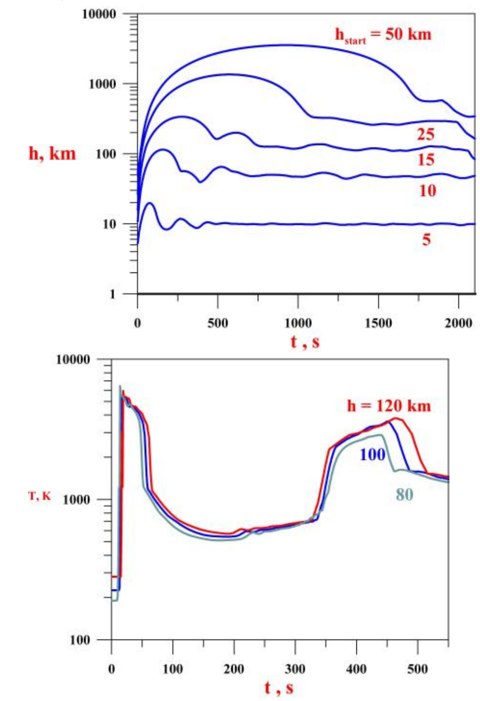

Fig 1.

Simulation of electric currents induced by the plume and the Earth's magnetic field disturbances: The main equation for currents is deduced from stationary Maxwell equations. Since parallel conductivity greatly exceeds Pedersen's and Hall's conductivities, calculated for the plume, the latter are integrated over height of a layer, in which Lorenz's force generated by the motion of the plume acts. The magnetic field of the current system induced by the Lorenz's force is also numerically derived from the stationary Maxwell's equations. In fig.2 disturbances of two components of the geomagnetic field are presented for the time moment 400 sec and azimuth of trajectory 90 degrees (magnetic field is expressed in nT and lengths- in km).

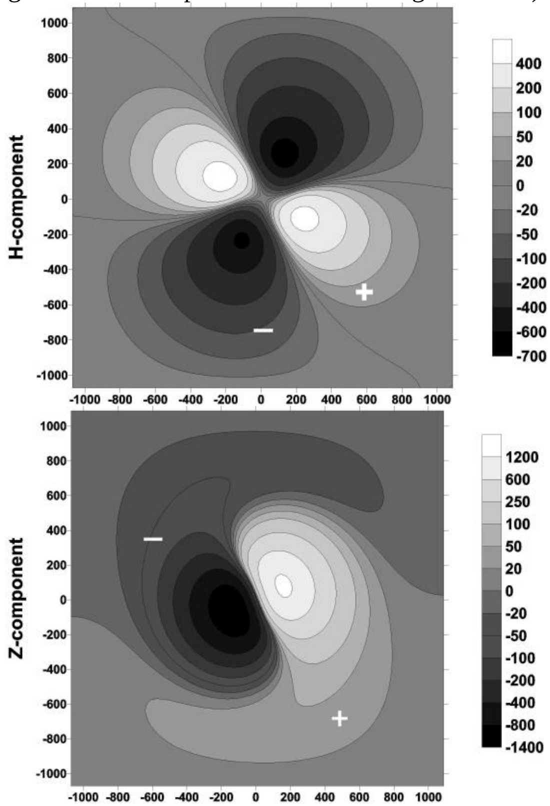

Fig.2

Discussion: Key features of the geomagnetic effect which we have tried to reproduce in simulations were the start point (6 -6.5 min after the explosion) and signs of H- and Z-component disturbances, both positive at the beginning.

The pattern of the geomagnetic disturbances at a local point on the ground (the point of the Irkutsk observatory, namely) is affected by azimuth of the meteoroid's trajectory, because after explosion the plume moved along the trajectory in the opposite direction. Previously the azimuth of the meteoroid's trajectory was defined by a picture on the ground, by witnesses and astronomers [6] in a range of 100-164 degrees, if to count clockwise from the north. Simulation of the induced magnetic field have shown that positive disturbances lie in a rather narrow interval of azimuths, that permits to define a reasonable azimuth close to 160 degrees by the independent method.

We have defined that the start time moment about 400 sec corresponds to the time moment when the meaningful portion of the plume already fell down. Simulations the geomagnetic field disturbances at time moment 300 sec-(i.e. before the start) have shown that the disturbances of H- and Z- components are out of the threshold of the magnetographs [1]. At this time the lower ionized portion of the plume was rather high above the E-layer of the ionosphere.

Conclusions: Important features of the geomagnetic effect, caused by the Tunguska event have been simulated: the time delay, the sighs of disturbances of two components of the geomagnetic field at early times of evolution. The azimuth of the trajectory has been defined. Indirectly the initial data used for gas dynamical simulations have been validated. Assessing hazards of those events ionospheres and magnetic disturbances should be taken in account.

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