IONOSPHERIC AND MAGNETOSPHERIC DISTURBANCES CAUSED BY IMPACTS OF ASTEROIDS AND COMETS. I. V. Nemchinov, Yu. I. Zetzer, A. T. Kovalev, V. V. Shuvalov, Institute of Geosphere's Dynamics, Russian Academy of Sciences, 38 Leninsky pr., bldg. 1, Moscow, 119334, Russia; e-mail: ivvan@idg.chph.ras.ru

Disturbances in the Earth's ionosphere and magnetosphere caused by impacts of asteroids and comets are studied. The 2D hydrodynamic numerical simulations of a cosmic body passage through the atmosphere with allowance for deceleration, deformation and disruption due to aerodynamic loading and formation of the wake behind the body are performed. A plume (a mixture of the air and the products of "explosion" after the impact onto the land or into the ocean) is formed. Rising plume reaches high altitudes, operating as a MHD generator. Field-aligned currents heat the lower layers of the ionosphere and change their conductivity. A part of the plume moves at higher than escape velocity and may pierce the ionosphere and magnetosphere.

For a 1-km body the energy of the high-velocity part of the plume is comparable to that of the Earth's magnetic field (~200 Mt TNT). The magnetic field cannot stop the plume. The magnetosphere is severely distorted, Van Allen belts disrupted.

For a 30-60 m cosmic body (Tunguska-like object) the plume rises up to a height about 400-500 km and falls back due to gravity, heating the atmosphere at altitudes above ~100 km, and change conductivity. The magnetic storm lasting several hours with amplitude of about 70 nT was observed in Irkutsk (at the distance of about 900 km from the impact point). Impacts of bodies with sizes of 1-2 km are rather rare events. Consequences of the Tunguska-live impacts are not very severe, at least at the regional scale. So we studied impacts of small cosmic bodies with sizes from ~0.1 km up to 1 km.

The MHD numerical simulation of the motion of the plume and its interaction with the geomagnetic field are performed. Excitation of MHD waves is demonstrated with amplitudes of 10^2-10^3 nT. These disturbances are capable of triggering precipitation of particles from Van Allen radiation belts, increase ionization at lower altitudes, produce intense electromagnetic noise.

Lower parts of the plume increase the air density at large distances from the impact point. For an example, a 400-m stony body, with the initial velocity of 17 km/s impacting the ocean for the moments of 200-600 s increase the density in the cylinder with radius of 1600-1800 km and altitude of ~2000 km up to the density of 10^{-14} g/cm^3, which corresponds to the normal density at the altitude of ~350 km. That changes the recombination rates and increases the ionization due to solar radiation and cosmic rays. This effect resembles rising the F2 layer of the ionosphere up to altitudes of 1000-2000 km. Radii of the density disturbances at higher altitudes are much larger – they reach 5000-7000 km at an altitude of 1200 km at the same moments of time.

Large mass of the plume falls back due to gravity and produced intense oscillations of the ionospheric conducting layers propagating to very large distances from the impact point. So the disturbances may have global character.

We note that recently found asteroid 2004 MN4 has the size of about 300-400 m. It will pass the Earth in 2029 at a rather small distance – about 36000 km. There is some possibility that trajectory of the asteroid will change and it may hit the Earth in 2035-2039, most probably into the ocean. Its energy is about 3.10^4 Mt TNT. Tsunami created by the impact will provide devastating effects. But in addition severe magnetospheric and ionospheric disturbances may make the normal work of some technical systems of the modern civilization not possible: they will disrupt radio communications, hinder TV broadcasts and radiolocation and produce great errors in the location by GPS system and so on.

Determination of the time necessary to restore normal state of the ionosphere and magnetosphere is the goal of the future research.