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Ionospheric and magnetospheric disturbances caused by impacts of small comets and asteroids.

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Disturbances in the Earth's ionosphere and magnetosphere generated by impacts of small comets and asteroids (with the size from 30 m up to 1 km) are studied. The 2D hydrodynamic simulations of the cosmic body descent through the atmosphere were conducted taking into account deceleration and disruption due to aerodynamic loading. Formation of the rarefied wake facilitates ejection of the plume (high-speed jet of hot air and cosmic body debris). For the size of 30-50 m the descending stream of comet debris did not reach the Earth's surface. The plume rises to the altitudes of about 500-1000 km and falls back, heating the atmosphere at altitudes above - 100 km, changing the conductivity of the ionosphere. That is probably the cause of the magnetic disturbances detected after the Tunguska event 1908 in Irkutsk at the distance of $\sim$900 km from the epicentre of the "explosion" (with the energy of about 10-15 Mt TNT at an altitude of about $\sim$5 km). The amplitude of the magnetic field variations lasting for about two hours was similar to that of the moderate magnetic storm. A 1-km impactor hits the ground and creates large crater. The energy of the rising plume exceeds that of the whole Earth's magnetosphere, and the plume pierce and deform the magnetosphere, disrupts the van Allen radiation belts and so on. So in the range of sizes under investigation the character of the consequences of the impact change from local to global. Numerical simulations for comets (the impact velocity of 50 km/s) with initial radii R_0 = 100 m and R_0 = 200 m show that they reach the surface but in a disrupted form, and the energy is mainly released in the atmosphere. The plume reaches 1000 km for R_0 = 100 m and 1400 km for R_0 = 200 m in 30 s and 40 s, respectively. At that moment some part of the plume still retain the velocity higher than the escape velocity. The energy of that part of the plume is about 0.14 and 3 Mt TNT, respectively, and that is already comparable to that of the magnetosphere.

The 2D MHD simulations have been conducted for the case when the plume rises vertically at the pole. The rising plume expands and due to this radial velocity a wide cone is filled by magnetosonic disturbances propagating with the Alfvenic velocity. Approximate 2D numerical solutions were also obtained for plume rising vertically at the equator. Estimates based on simple models show that these disturbances lead to precipitation of particles from the radiation belts and, on the contrary, some of the injected particles fill the magnetic field tubes and become trapped. That leads to the magnetic disturbances comparable to that of the intense magnetic storms. Moreover, the main part of the rising plume with huge energy (much large than that of the high-speed jet) falls back due to gravity and causes radial propagation of the acoustic-gravity waves all around the globe. All these factors cause intense electromagnetic noises, disruption of radio communications, distortions in GPS locations and so on. So even for cosmic bodies with R_0 from 100 m to 200 m the impacts have global consequences, though “traditional” consequences (shock waves, fires, cratering, rising dust, tsunamis and so on) are still regional.