Dust particle dynamics in convective vortices near the surface of the Earth: analogies with Mars

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The work is devoted to the study of the dynamics of dust particles in convective vortices above the surface of the Earth and Mars. Dust vortices (dust whirlwinds or dust devils) often occur in the conditions of the Earth and Martian atmosphere. A feature of this type of vortex is the involvement of a large amount of dust from the underlying surface. Vortices arise over well heated surfaces as a result of convective instability. The characteristic dimensions of these vortices on the Earth are from the order of several meters to several hundred meters, while on Mars, the dimensions of such vortices can be ten times larger than those on the Earth. Rotating in a vortex, dust particles collide and acquire electric charges, after which a macroscale electric field arises as a result of spatial separation of charges. The study of the dynamics of vortices and dust particles in them in the Martian atmosphere is of considerable interest, in particular, due to the significant contribution of dust to the radiation balance in a rarefied atmosphere. Observations and direct measurements of the parameters of terrestrial dust vortices over desert surfaces on the Earth are possible and periodically carried out. Similar measurements on Mars are difficult. In this work, it is proposed to use the similarity theory to predict the parameters of Martian vortices, using data obtained on Earth. The behavior of dust particles in a vortex is simulated, taking into account forces of various nature, including the influence of the electric field generated by the vortex on the trajectories of dust particles in the vortex. The work is supported by the Russian Science Foundation (project No 18-72-00119) and the Russian Foundation for Basic Research (project No 18-02-00341).