Ion trapping by charged dust particles and producing of large electric fields in mesospheric dusty plasma

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Numerical simulation of behavior of charged particles in the mesospheric dusty plasma is used for investigation of the plasma features leading to the formation of the large electric fields observed in the mesosphere in rocket experiments. Numerical simulations allowed to reveal the effect of ion trapping by multiply charged dust particles to quasi-closed orbits due to collisions of the ions with background neutral gas occurring near dust particles charged by another sign. We proposed the effect of ion trapping is responsible for generation of V/m vertical electric fields observed in the night lower mesosphere and in the polar summer mesopause in the vicinity of noctilucent clouds (NLC) under strong electron biteout conditions, that is, in the absence of free electrons. The effect of ion trapping may be important for the large electric field formation if both positive and negative multiply charged dust particles are existence in the mesosphere and if positive and negative ions are trapped by the charged dust before their mutual recombination. The main result of the ion trapping is a drastic decreasing of the ion conductivity. The V/m vertical electric fields observed in the mesosphere can be produced in the dusty regions with the extremely low electrical conductivity by vertical current of the global atmospheric electric circuit, currents caused by high-energy electron and proton precipitations, and gravitational sedimentation of charged dust. Calculations show that ion trapping by charged dust particles in the mesosphere in the absence of free electrons will take a place before ions recombine in their mutual collisions if each dust particle carries only a few unit charges. When electrons are present, the positive ion trapping by charged dust particles will take a place before ion recombination only if each dust particle carries a few tens of unit charges. At now, this value seems to be very unbelievable in the mesosphere. As for electrons, the calculations showed that the electron trapping by dust particles due to inelastic collisions could take a place in the NLC vicinity only by particles carrying more than 100 unit charges.