Influence of Dust Storms on the D-region Conductivity of Mars

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Dust aerosols in the atmosphere of Mars play an important role in the Martian climate system. Their presence not only affects the thermal structure of the atmosphere, but they may also generate lightning and cause electric discharges. Martian dust can acquire electrical charges because ions can charge dust aerosols by attachment. As there are no direct observations of electrical conductivity on Mars, it is important to provide theoretical estimates of the same and predict the magnitude of electrical fields that can be found on Mars. To carry out such a study, we have modeled the ion densities in the D-region ionosphere of Mars during a heavy dust storm. The model includes all major ionospheric processes through 120 chemical reactions and the continuity equations are solved along the vertical dimension. The neutral dust aerosol density is constrained through the dust opacities observed by THEMIS (THermal EMission Imaging System) onboard the Mars Odyssey. Using our model, the positive and negative ion densities are found to reduce by about two orders of magnitude near the surface. Since the ion conductivity on Mars depends on the density of charged particles, or calculations suggest that in the presence of heavy dust storms, the conductivity reduces by an order of magnitude. We have also calculated electric field (~40 kV/m) near the surface of Mars. This information is important to establish a global electric circuit on Mars. On Earth, the circuit is maintained by thunderstorms, while on Mars the source is believed to be dust storms.