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Electric Dust Devils and Dust Storms

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Dusty convective plumes and dust devils are frequently observed in terrestrial deserts and the Martian landscape. Terrestrial dust devils produce heat and dust fluxes about two and five orders of magnitude larger than the background atmospheric value. Indeed, dust devils are important sources of atmospheric dust on both Earth and Mars. Laboratory experiments being carried at the University of Michigan show that microdischarges occur when sand and dust particles collide with each other. These microdischarges produce non-thermal electromagnetic radiation that can be fingerprinted with properly designed sensors. Negatively charged dust particles of a few micron in diameter then rise with the updraft, while the larger positively charged sand particles stay in the saltation layer. This produces charge separation and the bulk electric fields observed in terrestrial dust devils and dust storms. The dust particle concentration and the dust devil/storm size can be used to calculate the maximum electric field generated by them. We show that Martian dust storms can produce electric field gradients more than an order of magnitude larger than that necessary to produce electric breakdown. Thus, it is very likely that Martian dust storms produce electric discharges and that their bulk electric field gradient is limited by the breakdown value of $\sim$20 kV/m. Finally, in a related paper (Atreya, Renno,Wong, Mahaffy—Organics, Methane, Oxidants, and Habitability of Mars– this EGU) we present results of electrochemical models that show that these electric activities produce large quantity of hydrogen peroxide in the Martian atmosphere and surface. Laboratory experiments to test theses results are currently being designed by our group at the University of Michigan.