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Planetary aerosol electrification: Lessons learned from a terrestrial analogy for Venus

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Planetary atmospheric electrification has the potential to damage spacecraft, yet for planets with thick, deep atmospheres such as Venus, the level of electrification remains open to interpretation. Partly due to the difficulty of access and potential hostility to spacecraft, there are limited in-situ observations of deep atmospheres, making terrestrial analogies attractive. One proposed explanation of the observations of near-surface electrification on Venus from sensors on Venera 13 & 14 is a haze of charged aerosol. As the Sahara is an environment with lofted dust that is potentially similar to Venus in terms of atmospheric stability, a simple model was developed estimating a mean aerosol charge based on typical Saharan haze aerosol distributions. Spacecraft surface area and descent speeds were used to estimate the accumulated charge and discharge current measured by the Venera missions, but this model underestimated Venera's electrical measurements by three orders of magnitude. This suggests that an aerosol layer alone cannot explain the charge apparently present in the lower atmosphere of Venus. The simple terrestrial analogy employed may not have been suitable due to the modified pressure and temperature profile affecting the mean free path, ionic mobility and consequently the mean charge. Discrepancies in atmospheric stability and wind patterns must also be evaluated, as the effect of terrestrial wind on aerosol distributions may not be directly applicable to other planets. More detailed calculations of ion-aerosol attachment and re-evaluation of the terrestrial analogy may be able to resolve some these issues, but it looks likely that additional significant sources of charge are required to explain the Venera observations. Triboelectric charging of lofted surface material could exceed charging observed in terrestrial situations, or some unknown atmospheric or non-atmospheric source of charge could have contributed to the Venera electrical measurements.