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Estimating Solar Panel Degradation due to Aerosol Deposition using Discrete Dipole Approximation

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Experiments reveal that aerosol deposition decreases the efficiency of solar panels. Many optical aspects of these losses of efficiency are not well understood since they are related to the microphysics of the particle substrate system. These effects not only could result in revenue losses on Earth, but also could be disastrous to a space mission relying on solar power in a dusty planetary environment such as Mars. In this study, we explore the viability of using discrete dipole approximation (DDA) as a method to simulate the particle-substrate system. Initial theoretical results indicate that for spherical particles in free space, DDA does match the extinction and scattering efficiency calculated by Mie theory. Similarly, we applied DDA to a particle-substrate system where the substrate had its index of refraction n = 1.0001, approximately equal to that of free space. Our results indicate that the backscattered phase function matched the expected behavior as calculated by Mie theory. Finally, we have taken spectral measurements of hematite deposited on glass slides, and we are currently working on being able to predict the light transmission of this system. In future work, we expect to match the light transmission behavior of the hematite-glass system, and then conduct an extensive study with several variations of glass and dust properties. Our study has the potential to predict solar cell performance during particle deposition as needed for solar power forecasting and optimization of cell cleaning schedules and procedures.

This material is based upon work supported by the National Science Foundation under Grant No. IIA-1301726. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.