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Abstract: We present a new method, its development, implementation, and verification, for calculating the transient thermal interaction between lunar regolith and moving spacecraft travelling across the surface of the Moon. Regolith temperatures can be determined for lunar landscapes as defined by laser altimeter remote sensing data refined with local crater and boulder models. The purpose of this approach is to enable more detailed, dynamic thermal analyses of mobile systems on the lunar surface rather than relying on worst case, boundary condition design approaches typically used for spacecraft thermal engineering. This new simulation method is based on integrating models that represent small and large scale landscapes; reproduce regolith and boulder temperatures on the Moon; define the position of the Sun; and perform ray tracing to determine infrared and solar heat fluxes between passing objects and the surface. The thermal model of the lunar regolith enhances established models with a slope-and depth-dependent density. The simulation results were verified against remote sensing data obtained from the Diviner Lunar Radiometer Experiment of the Lunar Reconnaissance Orbiter (LRO) and from other sources cited in the literature. The verification results for isolated regolith surface patches showed a deviation from established models of about ± 3–6 K (± 1–6 The proposed new method could be further enhanced to address scientific
questions by incorporating more detailed regolith and boulder models, or be used as-is to evaluate
the dynamic thermal envelope of moving spacecraft.

Stichworte:
Lunar regolith; thermal model; transient simulation; engineering tool

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