KRC Thermal Model Support for Airless Bodies

R.L. Fergason[1], S. Piqueux[2], C.S. Edwards[3] and H.H. Kieffer[4]

[1] *U.S. Geological Survey Astrogeology Science Center, Flagstaff, Arizona, United States E-mail: rfergason@usgs.gov*

[2] *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, United States*

[3] *Northern Arizona University, Flagstaff, Arizona, United States*

[4] *Celestial Reasonings, Reno, Nevada, United States*

The KRC thermal model has been recently modified to enable the accurate modeling of surface temperatures on airless bodies, including the Lunar surface and near-Earth asteroids (*Piqueux et al.*, 2018). The user has the option to utilize four different surface photometric models: 1) Lambert; 2) LommelSeeliger; 3) Minnaert; and 4) Lunar-like. The code set can also handle two kinds of eclipses: 1) daily, as in for Jovian satellites, and 2) rare or solar, in that the lead-up days did not have an eclipse, such as when a satellite casts a shadow on the planet. For Jovian (and similar) satellites, reflected and thermal radiation from the planet can be significant, especially during an eclipse. A sinusoidal approximation for these components has been included for each. The finite size of the eclipse body is included in computing distances, but this is important primarily for Phobos' shadow on Mars.

The KRC model is derived from the Viking Infrared Thermal Mapper (IRTM) thermal model (*Kieffer et al.*, 1977), further described in *Kieffer* (2013), and with significant modifications incorporated since that date (*Piqueux et al.*, 2018). In the KRC thermal model, an explicit forward finite-difference scheme, calculates surface and subsurface temperatures by solving the heat conduction equation while satisfying a surface boundary condition that includes upward emission and downwelling thermal radiation and direct and diffuse insolation. Subsurface layers increase in thickness exponentially with depth, and are scaled to the diurnal skin depth. The appropriate physics are included to model surface temperature for conditions that include variable thermophysical properties (i.e., thickness, conductivity, density, and specific heat) for n layers, and layer depths may vary with albedo or emissivity. The lower boundary can be insulating, a constant temperature, or include a user-defined geothermal heat flux. This model also can incorporate the effects of a radiatively-coupled sloping surface at any azimuth. The effects of 3-dimensional blocks on the surface are not considered. In addition, the KRC thermal model can account for an atmosphere of any condensable gas (in addition to no atmosphere). The local atmospheric frost point is determined at each input using the local partial pressure computed for a specific elevation, season, and latitude. The atmosphere is treated as a one-layer atmosphere that is spectrally gray at solar wavelengths, and the direct and diffuse illuminations are computed using a 2-stream Delta-Eddington model. The atmosphere is radiatively coupled to the surface using an appropriate thermal capacity, and the thermal radiation is assumed to be gray and isotropic. The KRC thermal model is available for download from the KRC Wiki (http://krc.mars.asu.edu/index.php?title=Main_Page) and at the KRC GitHub repository (https://github.com/USGS-Astrogeology/krc_thermal_model)

References:

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