MODELING NEAR-SURFACE TEMPERATURES AT MARTIAN LANDING SITES. T. Z. Martin[1], N. T. Bridges[1], and J. R. Murphy[2], [1]Jet Propulsion Laboratory (4800 Oak Grove Dr., Pasadena, CA 91109), [2]New Mexico State Univ.).

Introduction: We have developed a process for deriving near-surface (~1m) temperatures for potential landing sites, based on observational parameters from MGS TES, Odyssey THEMIS, and a boundary layer model developed by Murphy for fitting Pathfinder meteorological measurements. Minimum nighttime temperatures at the MER landing sites can limit power available, and thus mission lifetime. Temperatures are derived based on thermal inertia, albedo, and opacity estimated for the Hematite site in Sinus Meridiani, using predictions of 1-m air temperatures from a one-dimensional atmospheric model. The Hematite site shows 9 % probability of landing at a location with nighttime temperatures below the –97 C value considered to be a practical limit for operations.

Approach one - using TES albedo/thermal inertia maps: Existing maps of albedo and thermal inertia derived from MGS TES data provide a ready means of predicting temperatures for any location, season, time of day, and dust opacity using a thermal model. Here we employ Murphy's boundary layer model [1,2] to generate air temperatures at 1 m for input values of A, I, opacity, season, and local time. Although the TES data are limited in spatial resolution, that instrument's excellent calibration provides reliable temperatures consistent with the body of evidence from Viking orbiter and lander data, as well as Pathfinder air temperatures.

Approach two - using THEMIS nighttime thermal imaging: The Odyssey THEMIS instrument, though not as well calibrated as TES, has 100 m imaging resolution in bands in the 10-12 μm range, and thus offers additional information about the spatial distribution of nighttime thermal regimes. We have explored the transformation required to infer from raw THEMIS brightness temperatures nightly minima at a differing local time and season. A more accurate approach would be to use THEMIS-derived inertias, once these become available.

Application: We model the nightly minima experienced by a MER rover at the Hematite site, near the end of the mission when temperatures are of most concern. This site also experiences the lowest temperatures, due to low inertia (dust-covered) regions in the landing error ellipse.

We find using approach one a 9% probability that the MER rover would land in a site where the temperatures fall below –97 C at Ls 30. Nightly minima can be expressed as contours in the albedo/inertia distribution (Fig. 1). For the Isidis candidate landing site, note the considerably higher inertia places it well beyond the region of concern. The minimum temperature map for Hematite (Fig. 2) shows the concentration of problematic low temperatures in the west part of the landing probability ellipse.

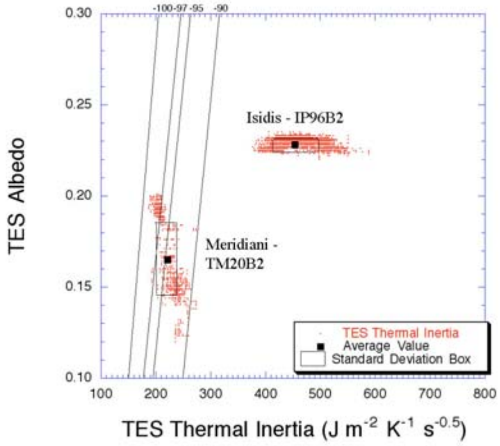
The THEMIS images are currently of value primarily for their spatial resolution; they show a variance of about 2 K across one strip within the Hematite ellipse.

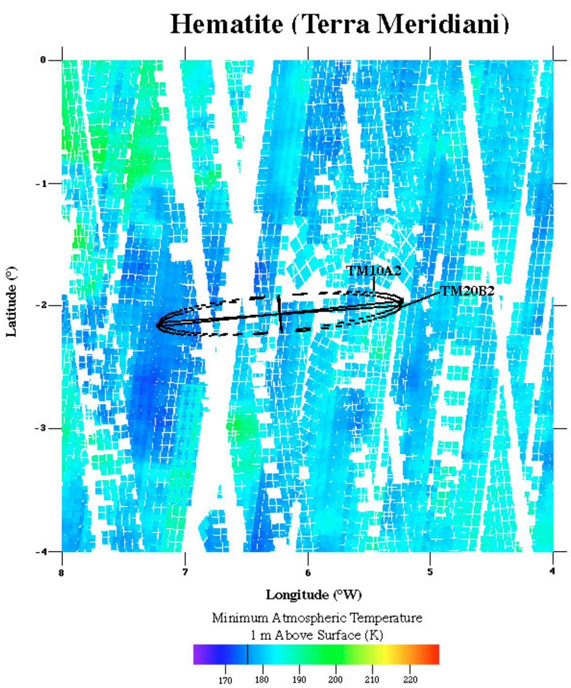
Discussion: We believe this approach will have other applications, both scientifically in modeling of near-surface environments, and technically to aid in future mission designs. Among the physical studies of interest are the transfer of water vapor and the development of daytime turbulence.

As mesoscale models [3,4] develop further, we expect them to take over a greater role in providing this kind of information. Winds clearly can affect the local thermal environment, mixing thermal domains horizontally and also mixing warmer air down from higher altitudes during nightly inversions. The THEMIS data will permit derivation of a zero-wind baseline for such work.

References:

[1] Haberle, R.M. et al. (1999) *JGR, 104,* 8957–8974. [2] Haberle, R.M. et al. (1997), *JGR, 102* 13301-13311. [3] Rafkin, S., et al (2001) *Icarus 151*, 228. [4] Toigo, A. and M.I. Richardson (2002), *JGR, 107,* 10,129.


-100 -97 -95 -90
Isidis - IP96B2
Meridiani - TM20B2
TES Albedo
TES Thermal Inertia
Average Value
Standard Deviation Box
TES Thermal Inertia (J m^{-2} K^{-1} s$^{-0.5}$)


Hematite (Terra Meridiani)
TM10A2
TM20B2
Latitude (°)
Longitude (°W)
Minimum Atmospheric Temperature
1 m Above Surface (K)
170 180 190 200 210 220