WHEN AND WHERE? PRIORITIZING TEMPERATURE MEASUREMENTS FOR THERMOPHYSICAL ANALYSIS.

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Introduction: Understanding the physical properties of planetary surfaces is aided by the measurement and interpretation of temperatures, either from orbit or *in situ*. In order to quantify thermophysical properties from these temperature measurements, a model describing the temperature as a function of time is required. Differences between employed thermal models (e.g., numerical architecture, atmospheric treatment, etc.) can affect the derived quantities. In addition, the conditions of the measurements themselves (e.g., local time) will influence the uncertainty in derived properties. Here we focus on the property of thermal inertia (TI) which controls changes in surface temperature under periodic solar forcing. We explore both spatial and temporal measurement conditions and identify those that result in accurate derivations.

KRC Model and Methods: The KRC model [1] is a well-established and validated 1D thermal model with many capabilities that are of use to the broader planetary science and engineering communities (see http://krc.mars.asu.edu for additional information). KRC has primarily been used for studies concerning Mars but is equally able to calculate temperatures for other bodies (e.g., Europa, Bennu, etc.; [2]).

We explore deriving TI and quantifying the effect of different measurement parameters, specifically local time, season, and latitude. We simulate a one-point mode that was developed for KRC in order to derive TI from a single temperature measurement, and has been used across multiple instrument datasets, including THEMIS infrared images [3]. Our approach involves prescribing model properties and generating diurnal and annual temperatures using KRC. We then use modeled temperatures, at a particular point in time and space, to derive a best-fit TI using the one-point mode. Under ideal conditions, the derived TI should be equal to the input TI. But in practice, numerical noise and modeling assumptions yield a difference which we seek to quantify. We can then assess specific temperature observations that yield the most dependable estimates of TI, applicable to all investigations involving thermophysical derivations.

Prediction and Results: Modeled temperatures for a range of subsurface properties and for a single location and season on Mars (Fig. 1) qualitatively display the effect local time on determining TI. Temperature curves of different TI materials intersect twice per sol. Temperatures acquired during "crossover" times should be avoided when deriving thermal properties, and part of our work is to establish the effective duration and timing of these crossover times.

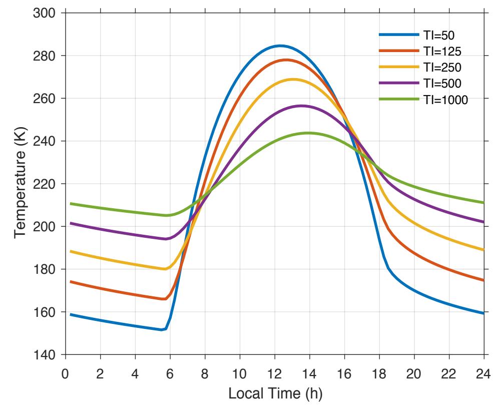

Figure 1. KRC modeled diurnal curves for Mars for a range of TI in units of J m^{-2} K^{-1} $s^{-1/2}$. Prescribed latitude is 12.5°N and L_S=120° (northern summer). Note overlapping temperatures at local times of ~600–800 and ~1600–1800 hours, complicating TI derivation.

The global analyses of Mars shown include three TI values of 50, 250 and 1000 J m^{-2} K^{-1} $s^{-1/2}$, a bolometric surface albedo of 0.24, a range in latitude between 87.5°N/S in 25° increments, and have a local-time resolution of 1 hour (Fig. 2). KRC tests values of TI between 20 and 2200 J m^{-2} K^{-1} $s^{-1/2}$.

The difference between prescribed and derived TI are greater during traditional crossover times (Fig. 1). High latitudes also experience considerable uncertainty, depending on season, possibly due to frost presence and nonlinear feedback it generates. There are also latitudinal dependencies, varying seasonally, causing the crossover times to drift in local time. There are also seasons for which data from typical crossover local times do not substantially impact derived TI (e.g., morning hours around southern summer solstice, L_S=270°). At the conference we will present – in addition to local time, season, and location – the effect of albedo and slope on derived-TI uncertainty for Mars and other bodies.

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References: [1] Kieffer H. H (2013) *JGR, 118,* 451–470. [2] Piqueux S. et al. (2018) *LPSC XLIX,* Abstract #1027. [3] Fergason R. L. et al. (2006) *JGR, 111,* E12004.

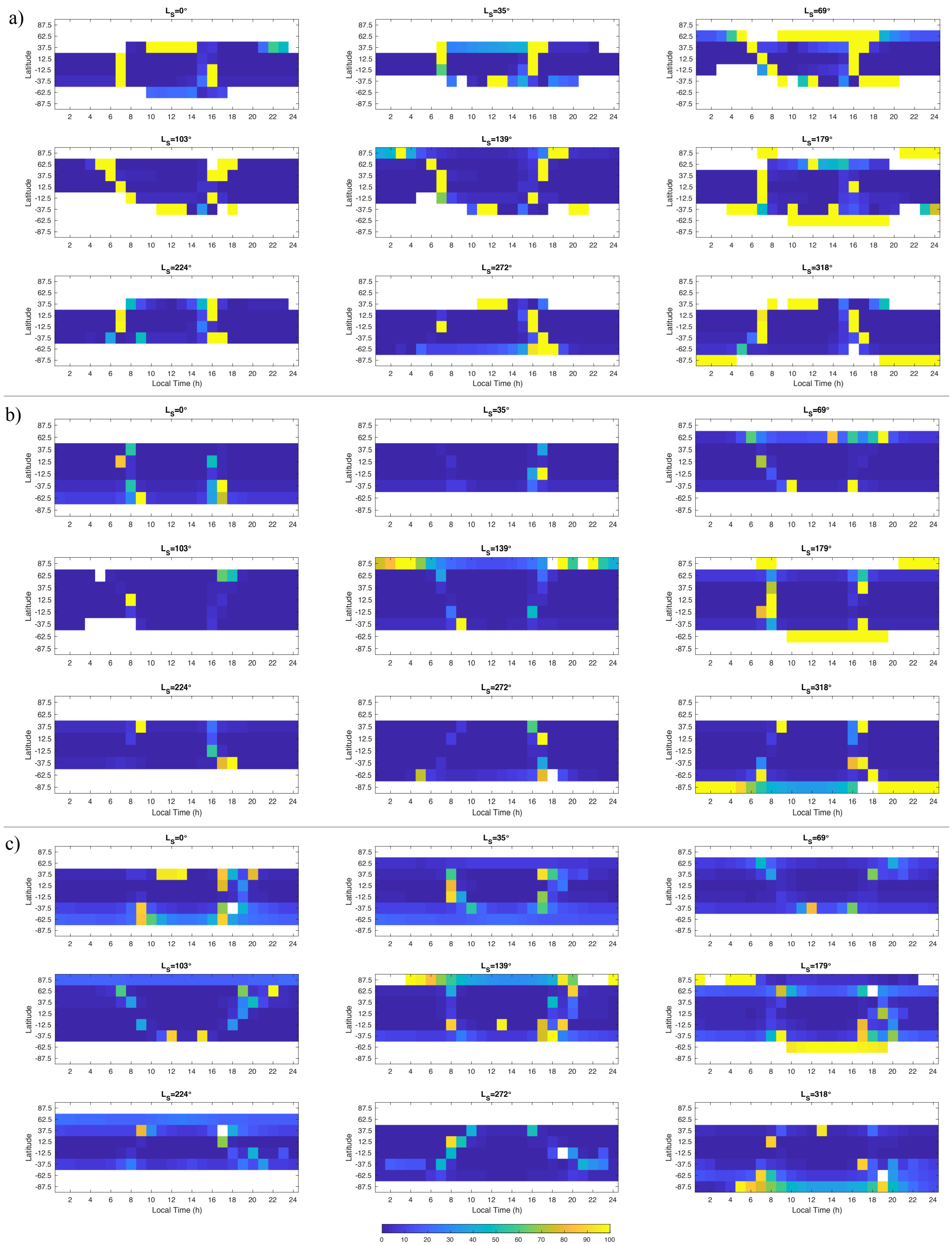

Figure 2. Absolute difference (in %) between the prescribed and derived TI for a) TI=50 b) TI=250 c) TI=1000 in units of J m^{-2} K^{-1} $s^{-1/2}$ using KRC and the simulated one-point mode for a range of latitude, seasons, and local time. Regions without color (white) are locations and times where a temperature fit was not possible (e.g., seasonal CO_2 frost was present, best-fit TI outside of range tested, etc.).