HIGH-RESOLUTION MAPPING OF THERMAL INERTIA FROM MARS GLOBAL SURVEYOR THERMAL EMISSION SPECTROMETER. M. T. Mellon[1], B. M. Jakosky[1], H. H. Kieffer[2], and P. R. Christensen[3], [1]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309-0392, [2]U. S. Geological Survey, Flagstaff, AZ, [3]Department of Geology, Arizona State University, Tempe, AZ 85287-1404.

Introduction: We use newly acquired Thermal Emission Spectrometer data from the Mars Global Surveyor spacecraft to derive and map the thermal inertia of the martian surface. Mapping mission data is providing a high spatial resolution of ~3 km (as apposed to ~100 km scale from Viking data analysis). This higher resolution will aid greatly in our understanding of the martian surface and geologic processes that act on similar scales.

Background: Diurnal oscillations in the temperature of the martian surface are strongly dependent on the thermal and physical properties of the top several centimeters of the regolith. Many factors have an effect including albedo, dust opacity, and atmospheric pressure, but thermal inertia is a key property in defining these temperature oscillations. Thermal inertia is defined as a combination of thermal conductivity k, density ρ, and heat capacity c:

$$I = \sqrt{k\rho c}\,.$$

Understanding the thermal inertia of a surface can help to identify the small-scale characteristics of that surface, even from orbit. Fine grained and loosely packed material typically exhibits a low value of thermal inertia, while higher values are common for rocks and exposed bedrock. The thermal inertia of a region of the martian surface is generally related to properties such as particle size, degree of bonding by duricrust, abundance of rocks, etc. Therefore, global mapping of thermal inertia provides insight into the physical character of the martian surface and the geologic processes that have modified that surface.

Observations: The Mars Global Surveyor Thermal Emission Spectrometer measures the surface temperature of Mars by broadband thermal emission (thermal bolometer) and spectral thermal emission (spectrometer), both of which can be used to determine the thermal inertia of the surface layer. The spectrometer-based temperature represents more of a surface kinetic temperature, while the bolometer based-temperature represents an integrated surface and atmosphere brightness temperature

Observations during Science Phasing and Aerobraking missions consist of limited high spatial resolution footprints acquired during periapsis and lower resolution footprints acquired during the remainder of the orbit. Mapping mission data consists of abundant daytime and nighttime high-resolution data with eventual global coverage. While, the lower spatial resolution data is sufficient for comparison with Viking IRTM thermal inertias and analysis of long term trends, high resolution data will provide a new look at the martian surface and greater insight into geologic processes. Thermal inertia can be derived from both daytime and nighttime observations.

Analysis and Methods: Previously, Palluconi and Kieffer [1981], and other investigators, have determined the thermal inertia from Viking IRTM data. They used day and night temperature observations to perform a two parameter fit of thermal inertia and albedo. (Thermally derived albedos typically do not look like observed albedos.) As a result of this two parameter fit, uncertainty in the derivation is split between thermal inertia and albedo.

To determine the thermal inertia we use single temperature observations, along with associated observations of dust opacity and albedo, and additional information on season, time of day, latitude, and surface pressure. We run a series of thermal models to generate a large lookup table of temperatures given a range of associated observations and a range of thermal inertias. We then interpolate to find the best fitting thermal inertia for the given set of observed parameters.

We utilize both TES thermal bolometer planetary brightness temperature and spectrometer surface temperature data in determining thermal inertia; our thermal model predicts both surface and planetary brightness temperatures.

This method differs from previous methods primarily in that our thermal model includes atmospheric radiative transfer and in that we use single temperature measurements and hold albedo fixed as an observed input parameter. Also, the additional use of a planetary brightness temperature differs from that of Viking data and analysis.

Previous Results: Previously we have determined thermal inertia from MGS TES data and mapped these results at 2x2 degree (latitude x longitude) resolution to compare with Viking IRTM-based thermal inertias. An example of this low resolution analysis is shown in Figure 1 for orbits 16-36 of the AB-1 mission phase. For comparison to Viking IRTM a 20 micron equivalent temperature was used, derivecd from TES spectral data.

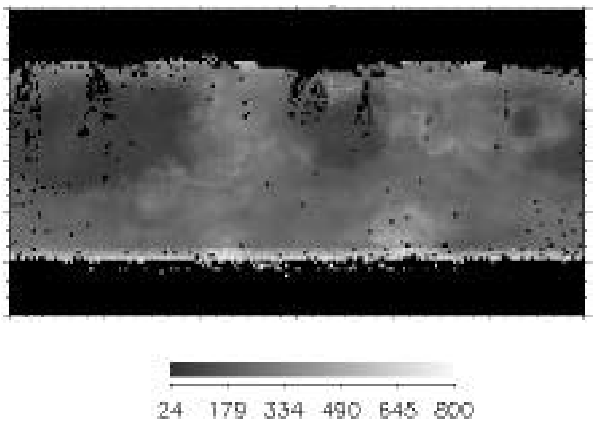

Fig. 1., TES 20-micron-based thermal inertia map. This map (a simple cylindrical projection) shows thermal inertia derived from data gathered during orbits 16-36. Latitudes range from pole to pole, longitudes are zero-centered. Large areas of low thermal inertia as seen in Viking results are evident. Thermal inertia units are J/m^2 s$^{1/2}$ K.

Mapping Mission: Now that we are in the mapping phase of the MGS mission, abundant high spatial resolution data (~3 km per pixel) is being gathered. Thermal inertias computed from these data show much more spatial structure and dynamic range than the 2x2 degree data previously mapped. The spatial structure correlates with observable geologic features on a similar scale and has great potential to lend new insights toward a better understanding of these features. The higher dynamic range, which is greatly "washed out" in the low resolution 2x2 data, has implications for a wider range of seasonal thermal behaviors than has been previously represented in low resolution data. Thus, at a given latitude a wider range of thermally controlled processes can occur than previously considered; for example, ground ice, whose stability depends strongly on subsurface temperatures, may be stable in regions where previous studies did not indicate. Mapping mission high-resolution thermal inertia data will be presented.