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Thermal mapping of mountain slopes on Mars by application of a Differential Apparent Thermal Inertia technique

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Thermal inertia (P) is an important property of geologic surfaces that essentially describes the resistance to temperature (T) change as heat is added. Most remote sensing data describe the surface only. P is a volume property that is sensitive to the composition of the subsurface, down to a depth reached by the diurnal heating wave.
As direct measurement of P is not possible on Mars, thermal inertia models (Fergason et al., 2006) and deductive methods (the Apparent Thermal Inertia: ATI and Differential Apparent Thermal Inertia: DATI) are used to estimate it. ATI is computed as (1 - A) / (Tday – Tnight), where A is albedo. Due to the lack of the thermal daytime images with maximum land surface temperature (LST) and nighttime images with minimum LST in Valles Marineris region, the ATI method is difficult to apply. Instead, we have explored the DATI technique (Sabol et al., 2006). DATI is calculated based on shorter time (t) intervals with a high $|\Delta T/\Delta t|$ gradient (in the morning or in the afternoon) and is proportional to the day/night temperature difference (ATI), and hence P. Mars, which exhibits exceptionally high $|\Delta T/\Delta t|$ gradients due to the lack of vegetation and thin atmosphere, is especially suitable for the DATI approach.
Here we present a new deductive method for high-resolution differential apparent thermal inertia (DATI) mapping for areas of highly contrasted relief (e.g., Valles Marineris). Contrary to the thermal inertia models, our method takes local relief characteristics (slopes and aspects) into account. This is crucial as topography highly influences A and ΔT measurements. In spite of the different approach, DATI values in the flat areas are in the same range as the values obtained by Fergason et al. (2006). They provide, however, more accurate information for geological interpretations of hilly or mountainous terrains.

Sabol, D. E., Gillespie, A. R., McDonald, E., and Danilina, I., 2006. Differential Thermal Inertia of Geological Surfaces. In J. A. Sobrino, ed., Second Recent Advances in Quantitative Remote Sensing, Publicacions de la Universitat de València,Spain, ISBN: 84-370-6533-X ; 978-84-370-6533-5, 193-198.
Fergason, R. L., Christensen, P. R., Kieffer, H. H., 2006. High resolution thermal inertia derived from the Thermal Emission Imaging System (THEMIS): Thermal model and applications, J. Geophys. Res., 111, E12004, doi:10.1029/2006JE002735.