GLOBAL MAPPING OF THERMAL INERTIA AND SURFACE HETROGENITIES FROM OMEGA/MEX. J. Audouard[1], F. Poulet[1], M. Vincendon[1], F. Forget[2], D. Jouglet[3], J.-P. Bibring[1], B. Gondet[1] and Y. Langevin[1], [1]Institut d'Astrophysique Spatiale (UPSUS/CNRS) Orsay, France; [2]LMD-IPSL (CNRS/UP6), Paris, France; [3]CNES, Toulouse, France. Contact: joachim.audouard@u-psud.fr

Introduction: The present-day structure of the Martian surface is the result of various processes that have shaped and modified it though time. The Martian surface structure is characterized by its thermophysical properties: thermal inertia (TI) and albedo. TI is a bulk parameter defined as the square root of heat capacity, bulk density, thermal conductivity and thus expressed in J m² K^{-1} $s^{-1/2}$. While solar albedo indicates the amount of solar energy available for the heating of the surface, TI controls its response to changes in temperature: a surface with high TI will heat and cool slower than a surface with low TI. On Mars, TI varies mostly as a function of volumetric thermal conductivity, thus grain size.

Comparison of surface temperature simulations with temperature measurements of the surface of Mars have been used to infer the thermal inertia of the surface since Mariner 9 aera [1], using themal infrared (> 10µm) spectrometers such as IRTM onboard Viking [2], TES onboard MGS [3] and THEMIS onboard Mars Odyssey [4]. Important works on these datasets revealed that very few bedock is exposed at the surface of Mars at a km scale [5] and reported anomalous thermal behavior relatively to homogeneous materials, attributable to horizontal or vertical mixing of different materials or local geometries [6, 7, 8, 9]. The thermophysical structure of the Martian regolith is a complex system yielding a single temperature measurement to produce apparent thermal inertia of the surface varying with local time and season as the real cycle of the surface differs from that of an homogeneous surface.

The purpose of this work is to study the TI of the Martian surface and its apparent variations using OMEGA measurements at 5 µm. Because of Mars Express' elliptical orbit, OMEGA observes the surface of Mars at various local times and can thus bring new constraints on the TI and heterogeneities of the Martian surface.

Data processing: We use radiance data from the Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité, which is a spectroscopic imaging system operating in the 0.36-5.1 µm wavelength range, in 352 separate channels ("spectels") [10]. At 5µm, the thermal component emitted by Mars at 200-280 K typically represents 15-95 % of the measured radiance. The OMEGA long wavelength channel is subject to change in its calibration level measured at the beginning of every orbit with an internal lamp. The radiances measured by OMEGA at 5 µm strongly depends on this calibration level. New ITF for non-nominal orbits were derived by [11]. Validation of these new ITF will be shown at the conference. The temperature is derived using the last four spectels from 5 µm to 5.1 µm by fitting a grey body to the radiance, as described in [11, 12]. Figure 1 shows a comparison between orbital OMEGA and in situ REMS surface temperature. The OMEGA-derived surface temperatures are actual co-observations and the agreement with in situ REMS temperature is remarkable.

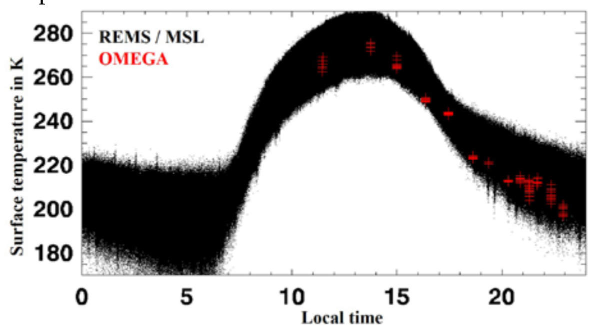

Figure 1. *OMEGA and REMS co-observations of surface temperatures at Gale Crater northern plains. The agreement between in situ and orbital data is excellent.*

Thermal inertia retrieval: Thermal inertia retrievals are performed through a comparison of single OMEGA-derived temperature with temperatures predicted by a 1D energy balance code developed at LMD and derived from a 3D GCM [13]. Model temperatures are simulated as a function of albedo (computed from OMEGA data, see contribution by M. Vincendon, this conference), local slopes and azimuth (computed from MOLA data), dust opacity (computed from MERs measurements and scaled to local pressure) and thermal inertia (left as a free parameter) and assuming an homogeneous surface. During certain times of the day, a given temperature is not uniquely related to a thermal inertia, preventing us to infer thermal inertia using a single temperature. Uncertainties are thoroughly estimated and represent typically ~20% of the TI value (up to 70% for low TI < 100 J m² K^{-1} $s^{-1/2}$). More information about the model and TI retrieval method can be found in [12].

Results: TI retrievals from OMEGA allow an unprecedented assessment of the apparent TI diurnal variations of the Martian surface caused by its heterogeneities. An example is shown in Figure 2 for a dusty region in Tharsis. Apparent variations of TI are not caused by various materials exposed at the surface but rather by surface heterogeneities affecting the same dusty material in agreement with higher resolution visible images. Several examples of apparent TI variations attributable to surface heterogeneities, including quantification, will be shown at the conference.

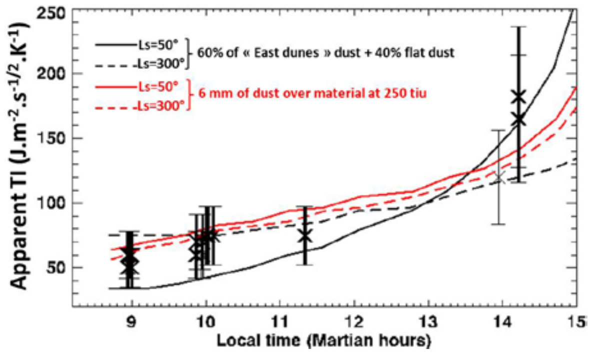

***Figure 2**. Apparent TI retrievals as a function of local time for a subarea of Tharsis between [135°W, 140°W, 4°N, 9°N]. Theoretical apparent TI diurnal variations of two heterogeneities are represented at two different Ls, when most of the data displayed here was acquired.*

We produce a global map of TI at a resolution of 4ppd. Several higher resolution local maps (up to 64 ppd) will be shown at the conference. The global map is presented in Figure 3 and is compared to published TI maps (TES [9] and THEMIS [4]) in Figure 4. Figure 3 depicts the main thermophysical classes of the Martian surface. Given the absolute and relative uncertainties on TES, THEMIS and OMEGA temperature data, different wavelengths and models, agreement between the three instruments TI products is good and validates our approach. 10 terrestrial years of OMEGA surface temperature data at various seasons and local times are available and shall therefore enrich our view of the thermophysical structure of the Martian surface.

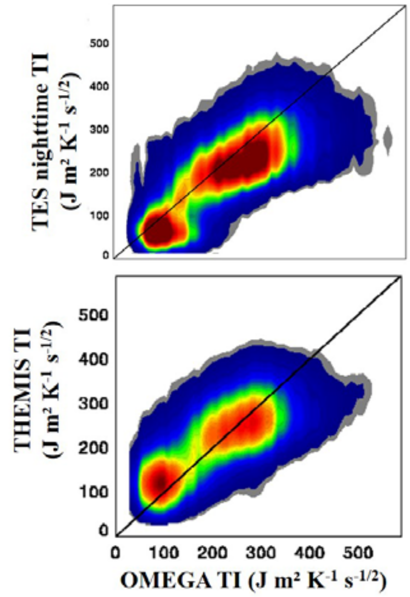

***Figure 4.** 2D histograms showing comparison of OMEGA-derived TI with TI derived from TES (top) and THEMIS (bottom). Solid lines are 1:1 lines.*

References. [1] Neugebauer, G. et al. (1971), *AJ*, 76. [2] Kieffer, H. H. et al. (1976), *Science*, 193. [3] Mellon, M. T. et al. (2000), *Icarus*, 148. [4] Fergason, R. L. et al. (2006), *JGR*, 111. [5] Edwards, C. S. et al. (2009), *JGR*, 114. [6] Jakosky, B. M. (1979), *JGR*, 84. [7] Bandfield, J. L. and Feldman, W. C. (2008), *JGR*, 113. [8] Nowicki, S. A. and Christensen, P. R. (2007), *JGR*, 112. [9] Putzig, N. E. and Mellon, M. T. (2007), *Icarus*, 191. [10] Bibring, J.-P. et al. (2004), *ESA SP* 1240. [11] Jouglet, D. et al. (2009), *Planet and Space Sci.*, 57. [12] Audouard, J. et al. (2014), *Icarus*, 233. [13] Forget, F. et al. (1999), *JGR*, 104.

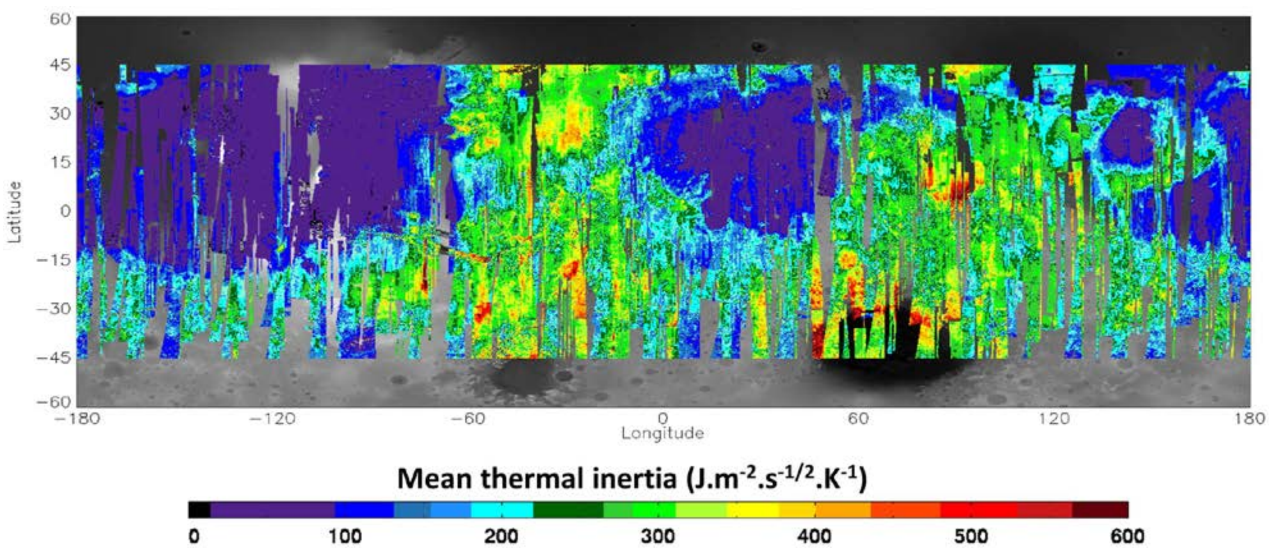

***Figure 3**. Global map of TI derived from OMEGA data at a resolution of 4ppd.*