IMPLICATIONS OF MER MINI-TES SURFICIAL AND ATHMOSPHERICAL TEMPERATURES EVOLUTION DURING A YEAR ON GUSEV CRATER, MARS. A. Molina[1,2,3], M. A. de Pablo[2] and M. Ramos[3], [1]Centro de Astrobiología, [2]Department of Geology, Univ. of Alcalá, [3]Department of Physics, Univ. of Alcalá.

Introduction: Mars Science Laboratory mission include an instrument focused on environmental data acquirement: the Rover Environmental Monitoring Station (REMS) [1]. It is designed to measure, among other variables, surface and atmospheric temperatures. The Mars Exploration Rovers (MERs) also have a spectrometer sensor, which allow derive these types of temperatures. We propose the analysis of Spirit's temperature data, which provide important information on (1) soil-atmosphere interaction, (2) the presence of liquid water and (3) characterization of surficial materials. These studies may be done again with REMS data, when MSL mission starts its scientific work on Mars surface, in order to compare results and to contrast with other data provided by other instruments.

Data: Mini-TES is a spectrometer instrument onboard the Spirit rover (MER). This vehicle landed in the inner plain of Gusev crater (Figure 1) and has been acquiring surficial and atmospheric data since 2004 [2]. Mini-TES instrument was designed for derive mineralogical and thermophysical properties, with a spectral range of 5-29 µm (339.50 to 1997.06 cm^{-1}) [3]. It is installed on the head of the Pancam Mast Assembly (PMA), located ~1.5m above the ground. It has 60 degree of azimuth travel and views from 30º above the nominal horizon to 50º below, what allow acquire data from soil to sky on the same place and practically at the same time.

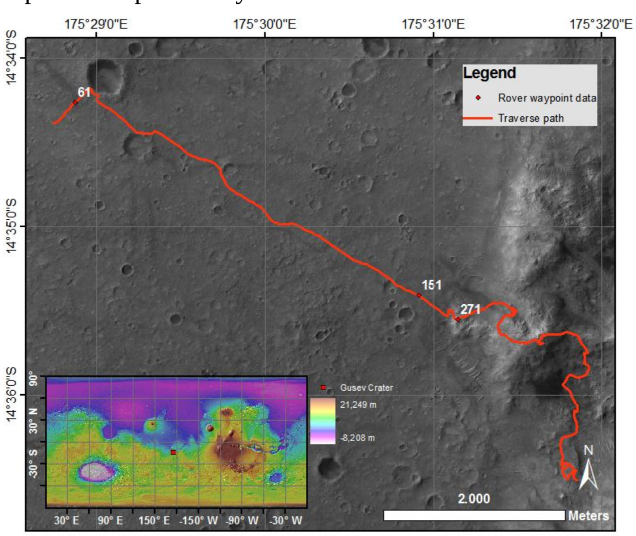

Figure 1: Location maps of Gusev Crater (red box) on MOLA topography (lower left corner) and path of MER Spirit mission (red line, from left to right). White labels mark the location of some representative Solar Longitudes (ºLs). Base map: HiRISE image (PSP_001513_1655).

Method: The possibility of acquiring data on different azimuth, allows to study surficial and atmospheric (near the surface) data. For a better understood of the temporal distribution of data, we take both surface and atmospheric each 15º Ls (about one Terrestrial month), during a complete Martian year (March 2004 – December 2005, on Earth) In order to normalize and generalize values, we also take data from the same local hour, but from one sol (Martian day) after, and one sol before, and deriving a mean value from these data from three consecutive days (Figure 2). Azimuths are 0.51º for atmospheric data and -0.39º (±0.11º) for surficial data. The local hour is 16h 40' (±40'), owing to is the time the sensor is programmed regularly to take the records.

Results and discussion: Resulting scatter plot from all these data (Figure 2, upper) shows a clear trend on both temperatures (surficial and atmospherical) following a sinusoidal wave behavior (characteristics are summarized on Table 1). Early on the year surficial and atmospherical temperatures decrease until reach a minimum at about 61ºLs. Then, these temperatures increase simultaneously until reach a maximum at 271ºLs, approximately. This trend is less clear in the second half of the studied Martian year.

In detail, surficial temperatures are about 75 K greater than atmospherical, and its maximum values reach the ice point in normal conditions (273.15K). However, similar trends on the temporal evolution of the atmospherical and surficial temperatures could indicate a lack of a remarkable phase transition on the surface. We propose it based on the case of wet permafrost, where soil temperature have a different trend than atmospherical (there is not changes on soil temperature) because all the energy is being spent on phase changes during thaw and freezing periods [4]. So the fact that both temperatures change at a time, could be indicative of an extremely dry environment.

During second half of the year data match less clearly to this sinusoidal wave trend (Figure 2). Terrain characteristics could explain in some way this behavior. Materials and reliefs tracked by the MER Spirit during the last part of its path are different, as it is possible to deduce from HiRISE image (Figure 1). On the first part, the mostly plain surface is covered by dust (regolith); meanwhile on the last part the hill are formed by exposed materials (rock outcrops). Then, different materials, means different thermal properties.

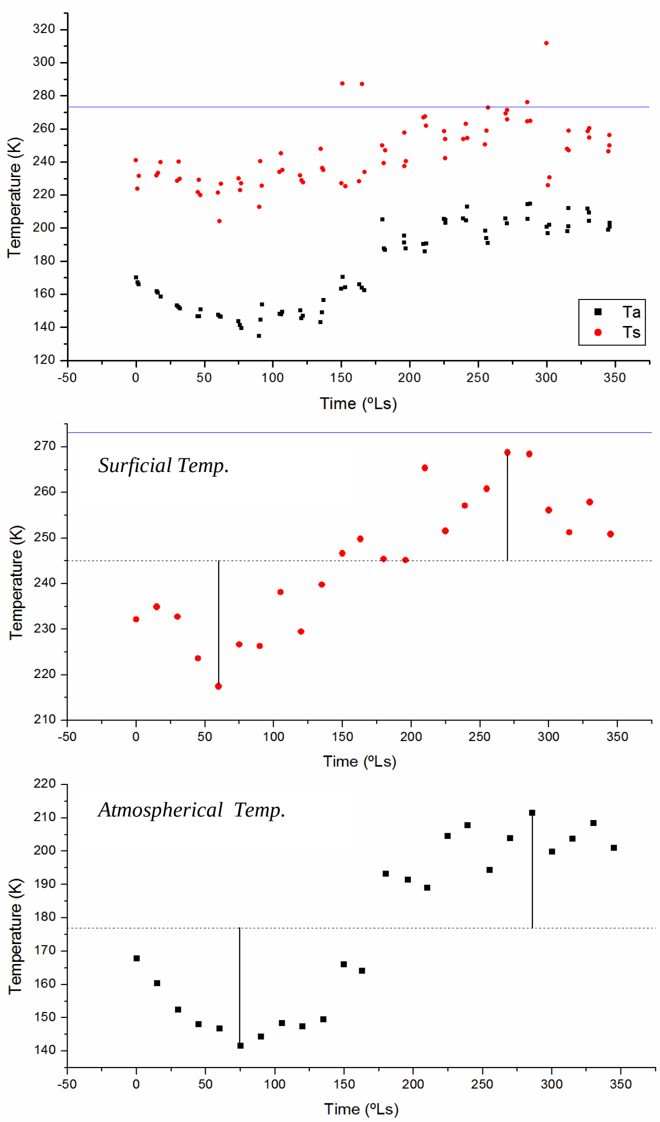

Figure 2: Scatter plots showing all studied temperature data (upper) and calculated mean values for surficial (middle) and atmospherical (lower), during a Martian year (on Solar Longitude, °Ls). Blue line is ice point temperature in normal conditions (273.15K), dotted line is mean value and vertical lines note the maximum and minimum values (sinusoidal wave amplitude).

	$T_{surficial}$ (K)	$T_{atmospherical}$ (K)
Maximum	269	212
Minimum	217	142
Mean	245	177
ΔT (Amplitude)	30	35
Frequency	360	360

Table 1: Main sinusoidal wave characteristics obtained from surficial and atmospherical temperature data, in Kelvin.

We also observed differences on data dispersion what could have important implications. In general, surface temperature data are more disperse, owing to the heterogeneous media, compared to atmosphere (Figure 2, upper). However, atmospherical temperatures are also quite dispersed, even more at the second half of MER Spirit track (Figure 2, lower). We think that it could be related to the temperature measurement method. MER Mini-TES instrument measure temperature through an IR sensor [3], which is high sensitive to suspension particles. Then, dispersed temperature values in the second half of the MER Spirit track could be attributed to higher particles concentration in the atmosphere. It could be due to dust storms, dust devils, or simply particles transportation by local winds.

Conclusions: Here, we analyzed Mini-TES temperature data in an innovative way. These types of data are not very frequently used by scientific community, and allow obtain very interesting information in a simply way. Analyzed data show a clear seasonal temperature cycle, with a sinusoidal wave pattern. This wave matches with both temperatures, atmospheric and surficial, what implies a lack of phase transition on surface. The influence of materials and, perhaps, climatic conditions can be also read on these data; which ideally would be crossed with another types of complementary data for reveal the uncertainness about its variability.

We do not discard other hypothesis to interpret the here presented data and trends, but we think that the ideas that we proposed should be strongly considered on future detailed studies about the Martian surficial and atmospherical temperatures and characteristics.

We propose increase studies with these types of data, having already validate its values [5], in order to apply to temperature data provided by different instruments, especially by forthcoming REMS/MSL.

References: [1] Gómez-Elvira, and REMS team (2008). *The Mars Atmosphere: Modelling and Observations.* Abstract # 9052 [2] Yen A. and Science Team A. (2007) *AGU* #P32A-05 [3] Christiensen P. R. et al. (2003) *JGR*, 108, 8064 [4] French, H. M. (2008) ISBN: 978-0-470-865688-0. [5] Molina et al. (2010) *II Iberian Meeting of the IPA, Proceedings.*

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