STUDY OF THE SURFACE TEMPERATURE AT NILI FOSSAE, MARS. PRELIMINARY RESULTS.
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Introduction: The surface temperature (ST) could provide useful information about the characteristic of the terrain and could be used, for example, for study of possible permafrost and the active layer behavior, as a factor for the habitability study, in which we are interested. The ST depends on a wide variety of climatic, geologic, geographical and topographic parameters (such as albedo, thermal inertia, latitude, season and dust opacity). The study of these parameters is useful to approach material composition, particle size, abundance of rocks, winds, and another physical and geological properties of a region of a martian surface [1]. This is why the obtaining of these parameters has been amply studied [2, 3, and 4].

We want to study the existence and evolution of the possible permafrost and active layer in Nili Fossae, what depends of the regional climate and the ST evolution. Here, we show our preliminary analysis of the ST and the different approaches that we done.

Methods: A general approach to the study of temperature could be done by the application of the MCD [5]. However, here we focused on the analysis of the Brightness Temperature Record (BTR) images from Thermal Emission Image System (THEMIS) experiment. First, we had used maximum and minimum ST values for all THEMIS infrared (IR) images available in the footprints file inside the study area (Nili Fossae). This area extends from 19º28'N to 22º30'N and from 72º40'E to 74º40'E. The footprints file was obtained from ftp server of NASA (ftp://ftpflag.wr.usgs.gov/) and represents footprints as of the data from the start of the mission (2002) to October of 2008. All ST are in degrees Celsius, and all figures use the same temperature and spatial scale.

The selected image footprints have a different range of latitude, what should be considerate for the analysis. This analysis is a quick method for a general characterization of the climate features in the region, and its evolution on time. Results are show in Fig. 1.

For a more detailed approach, we had calculated ST maps by the use of BTR associated to 4 images. This analysis allows developing a spatial characterization (100 m per pixel), in contraposition with previous analysis, what allows a regional study of the local ST. We select 2 pair of overlapping images (one IR daytime and one IR nighttime) with acquisition dates as similar as possible, from the THEMIS website (http://themis-data.asu.edu/). The selected images are I14576021BTR (acquired at Ls=183,248 and 17,737 local time) and I14308005BTR (acquired at Ls=170,907 and 5,524 local time) for summer; and I25920013 (acquired at Ls=332,818 and 16,432 local time) and I26538011 (acquired at Ls=359,373 and 4,449 local time) for winter. The ST maps were created by converting the DN values of the IR image pixels to brightness temperature using the formula:

*Temp = scaling _ factor * pixel_value + offset*

The scaling factor and offset (minimum temperature) can be obtained from the header of each image [6]. The result is a ST map for each image (Fig. 2). For the analysis, we also used a visible image of HRSC CTX (H1596_0001_ND3). We also made an N-S longitudinal profile across Nili Fossae (Fig. 3). For a comparison of seasonal and diurnal differences we overlapped a MOLA-derived DTM.

Results and discussion: The comparison of maximum and minimum values (Fig. 1) allow to know that the mean ST at the study area is -41.45ºC (-88,40 to -1,52ºC) for daytime and -83.62ºC (-35,66 to -112,11ºC) for nighttime. There is an important absence of data, what difficult us to interpretation correctly some trends form observed anomalies. One of them is the increase of night ST observed starting on 2006. This possible trend, with a decrease of diurnal ST, may

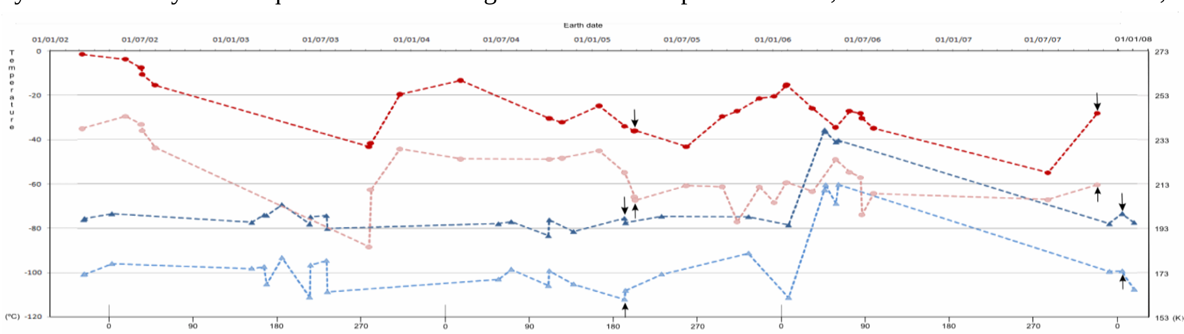

Figure 1. Maximum (dark color) and minimum (bright color) surface temperatures (ST, Celsius) contained in header of BTR THEMIS IR (daytime are red and circles, nighttime are blue and triangles) images inside Nili Fossae area. X-axis show acquired data for Earth (up) and Mars (down, in Ls). Arrows show images used in detailed analysis.

be interpreted as a dust storm. During this phenomenon, at daytime, solar radiation does not reach the surface, and then it is absorbed by suspension particles. At the nighttime period, these suspension particles emit IR radiation to the air, decreasing day-night temperature variation [7]. Another similar case is observed at the end of 2003, with an important decrease of daytime ST. In Fig. 1, arrows show the BTR images used in the detailed analysis of ST. They were selected on their representative and mean values of ST and their spatial overlapping

The ST maps and their overlapping (green polygon) are show in Fig. 2. For a more detailed analysis we made an N-S profile across the graven (Fig. 3), including 4 ST maps values and the topography. During the day, in winter, there is less variance in ST along the area, than other ST maps. Nighttime this variances are important (~100ºC). Inside the graben and some craters we found the highest ST values, during day and night, but without significant changes (Fig. 2). Variations in topography give rise to the most significant radiance (ST) oscillation [8], due to the effect of the insolation with the slope and orientation. Differential heating of slopes produces a clear picture of craters rims and slopes of principal reliefs in daytime (Fig. 2). Moreover, the differences of ST could be correlated to the thermal inertia of the surface materials. Thermal inertia represents the resistance to change in temperature of the upper few centimeters of the surface throughout the day, and is independent of local time, latitude, and season [6]. Particle size is the most important surface feature that is related with this parameter. Wide variation in ST is related to low thermal inertia, and fine particles have a lower thermal inertia [6]. Some accumulation of sand and eject material found on the graben (Fig 3, CTX image), have not relief and have wide difference of temperature. In highlands, the areas with fewer differences may be sand, duricrust or rock fragment.

Conclusions: The approach we propose here, give an important volume of information even in regional analysis. Detailed analysis allow to find out the influence of parameters like solar radiation, slope inclination, slope orientation, etc. In future, we pretend to extend this analysis in order to cartography different units by the ST study.

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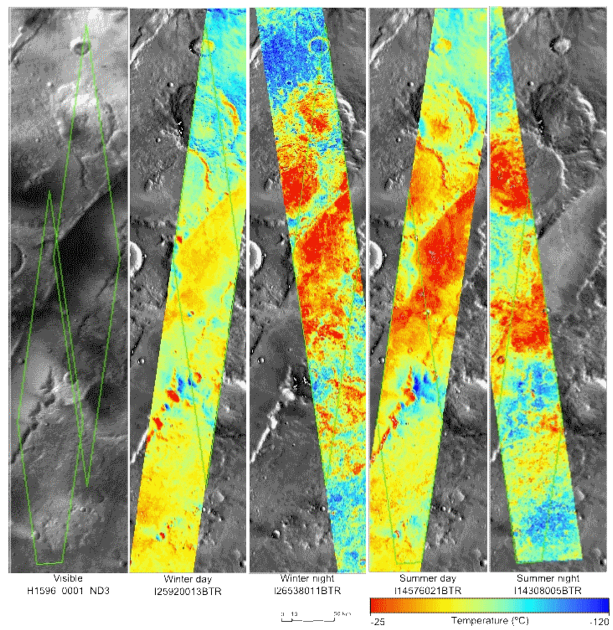

Figure 2. 4 ST maps (Celsius) created by 4 BTR THEMIS images, acquired in different time (daytime and nighttime) and data (winter and summer). Green polygon show overlap area. Left is a HRSC CTX image.

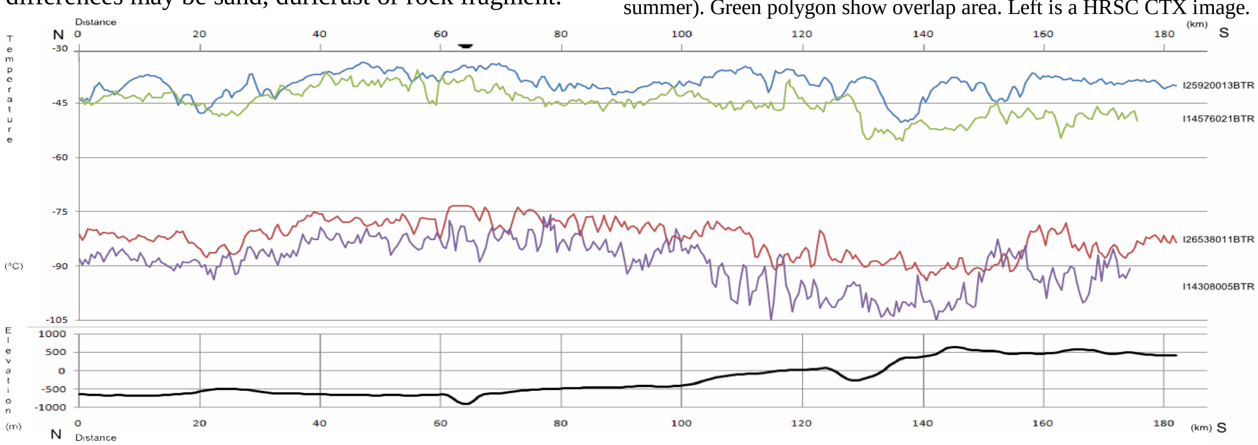

Figure 3. N-S profile across the Nili Fossae graben. It include surface temperatures (ST, Celsius) of 4 maps created by 4 BTR THEMIS images, acquired in different time (daytime and nighttime) and data (winter and summer) (up). Down is show the elevation (m) data (MOLA-derived DTM) for the same profile.