ANALYSIS OF CURIOSITY SURFACE TEMPERATURE DATA. J. Audouard[1], S. Piqueux[2], F. Poulet[3], M. Vincendon[3], B. Gondet[3] and D. A. Rogers[1], [1]ADpt of Geosciences, Stony Brook University, Stony Brook, U.S.A., [2] Jet Propulsion Laboratory, California Insitute of Technology, Pasadena, California, USA, [3]IAS, Orsay. Contact: joachim.audouard@stonybrook.edu.

Introduction: Since its landing in August 2012 in Gale crater, the rover Curiosity of the Mars Science Laboratory (MSL) NASA mission has performed many measurements to characterize its surroundings according to its science objectives [1]. In this work, we analyse the first year of data recorded by the Rover Environmental Monitoring Station (REMS) instrumental suite [2], and specifically by its Ground Temperature Sensor (GTS) which measures the temperature of the surface [3].

The temperature of the Martian surface is a complex function of the surface specific thermophysical properties (thermal inertia and albedo) and of the heterogeneity of the surface (horizontal mixing, and/or vertical heterogeneity, both expected on Mars). Using an Energy Balance model, we perform an analysis of GTS first year of data.

When comparing surface temperature measurements with energy balance model predictions, it is possible to estimate the thermophysical properties of a surface. This method has been used by [4, 5, 6, 7] to infer the thermal inertia of the Martian surface using "single point" orbital surface temperature measurements. In the case of *in-situ* Curiosity surface temperature measurements, GTS/REMS data is recorded on a 1Hz sampling basis, for an average on-time of a few hours per sol. This unprecedented dataset thus allows for more refined thermophysical properties and regolith heterogeneity retrievals and can potentially reveal some processes which remain not accounted for in the energy balance models. This interest of GTS/REMS data has recently been emphazised by a couple of studies [8, 9], revealing that the GTS/REMS dataset effectively holds some information about processes influencing the temperature of Gale crater floor that remain to be understood.

We have performed an independent study of GTS/REMS surface temperature first Martian year of data using a different LMD-derived energy balance code and fitting method that those of [8, 9]. The purpose of this work is to retrieve the thermophysical properties of the regolith along Curiosity traverse, and to study and discriminate the non-simulated thermal behavior caused by regolith heterogeneities and neglected processes in the energy balance code.

Method: We identify a few hundred "stops" where Curiosity was still and GTS/REMS was turned on for at least a few hours. We use an Energy Balance Code derived from the LMD GCM [10] that was used for thermal inertia retrievals from orbital surface temperature data [7]. For each stop, there is a unique combination of thermal inertia and albedo that best fits GTS/REMS data in the least square sense. Data-resolution comparison between these best-fit surface temperature simulations and the actual data yield to a diurnal residual thermal behavior given the limitations of the surface temperature simulations (vertical and horizontal homogeneity) and the complexity of the real Martian regolith.

Various processes un-accounted for in our model such as temperature-dependancy of the thermophysical properties [11] or the influence of the Curiosity nuclear power source are then added to the model, thus allowing an assessment of the different contributors to the observed thermal behavior. Comparison with orbital data will be presented.

Results GTS/REMS temperatures are in fair agreement with temperatures measured from orbit using OMEGA and TES, given the relative uncertainties and method discrepancy (Figure 1).

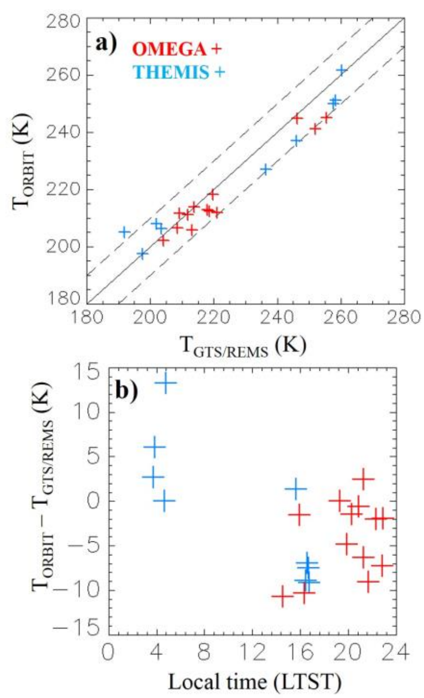

Figure 1. *Co-observations of surface temperatures : in situ with GTS/REMS and from orbit with OMEGA and TES.*

At first order, GTS/REMS data is well reproduced by the Energy Balance Code best fits. Figure 2 shows an example where the residual ΔT is about 10 K throughout the sol over a total signal of ~100 K. The residual ΔT are surprinsigly stable throughout the mission (sol-to-sol as well as stop-to-stop), relatively independent of the location of the rover and of the thermophysical properties of its surroundings.

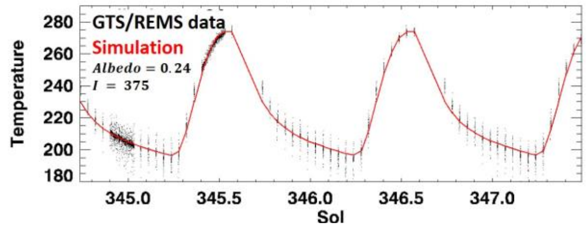

Figure 2. *Example of GTS/REMS surface temperature data and best fit simulation using an Energy balance code and the stated thermophysical properties.*

Figure 3 shows the average diurnal ΔT for the data corresponding to the four seasons and it can be seen that the non-accounted for thermal behavior is very regular: nighttime temperature measurements are always cooler that expected regarding the low daytime temperatures. Similarly, the morning heating happens to be really fast and the afternoon cooling is unexpectedly slow.

Deciphering the different contributors to this ΔT is ongoing, and first progress towards the integration and the impact of the temperature-dependency of thermal inertia are promising and will be presented and discussed at the conference.

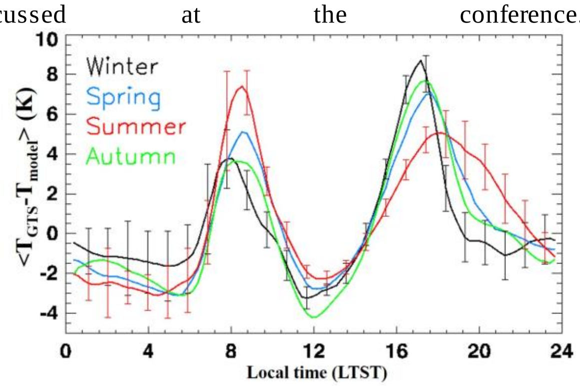

Figure 3. *Average residual ΔT (GTS minus best fit simulations) as a function of local time for the four seasons. Error bars represent the 3-sigma dispersion of the ΔT.*

A few K of the figure 3 thermal behaviour can be explained by this process. Additionnal T-dependant effects will be discussed.

We will also attempt to simulate the impact of the Curiosity nuclear power source by adding an energy input into the Energy Balance Model. Impact of mesoscale atmospheric processes (such as turbulences) will also be discussed. Our purpose is to estimate the impact of these different factors (T-dependancy of thermal inertia, impact of nuclear power source, mesoscale effect…) onto the GTS/REMS data in order to be left with a smaller ΔT that would be caused by the regolith thermophysical heterogeneities.

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