EPSC-DPS Joint Meeting 2019

FIRST THERMAL INERTIA MAPS FROM PFS/MEX DATASET TO TRACK ICE DISTRIBUTION ON MARS

Marta Ciazela (1), Jakub Ciazela (1), Daniel Mège (1), Marco Giuranna (2), Piotr Podgórski (1), Bartosz Pieterek (3), Joanna Gurgurewicz (1), Pierre-Antoine Tesson (1), and Paulina Wolkenberg (1,2)

(1) Space Research Centre, Polish Academy of Sciences, Warsaw, Poland (mc@cbk.pan.wroc.pl) (2) Institute for Space Astrophysics and Planetology IAPS, Rome, Italy (3) Institute of Geology, Adam Mickiewicz University, Poznan, Poland

1. Introduction

Tracking thermal inertia on Mars can provide unique information on thermophysical surface properties that complement information from images in the visible range [1]. The method is especially efficient at identifying seasonal surface ice showing highly enhanced thermal inertia (>1000 J m^{-2} $K^{-1}s^{-1/2}$) compared to martian soils (<600 J m^{-2} $K^{-1}s^{-1/2}$) [2] due to higher thermal conductivity and heat capacity of ice. We are using PFS/MEx dataset consisting of 1,424,366 surface temperature retrievals collected over 18438 Mars Express orbits (Figure 1), encompassing nine successive Mars years (Ls=331° of MY26 to Ls=21° of MY34 where Ls is solar longitude and MY - martian year).

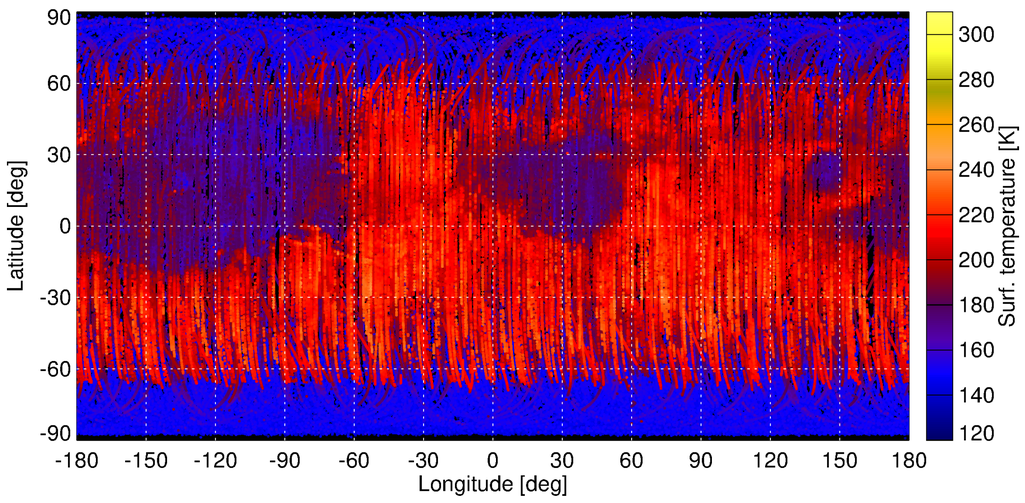

Figure 1. PFS/MEx nighttime surface temperature distribution on Mars averaged over 9 martian years (MY26-34)

2. Data and Methods

At first, we generated night-time temperature maps of Mars for 4 seasons and 12 time intervals (months) to investigate thermal distribution changes over time (Figure 2 and 3). We then calculated thermal inertia maps for Martian summer (Ls=90°–150°) and winter (Ls=270°–330°) using the apparent thermal inertia (ATI) approach [3]: ATI=(1-A)/ΔT, where A is albedo and ΔT is temperature difference. We used the PFS night-time and daytime temperatures database along with the global NIR 1-micrometer albedo map of Mars from the same mission. Albedo map is based on reflectance data acquired by the OMEGA/MEx spectrometer from January 2004 to August 2010 [4].

Seasonal nighttime temperature changes

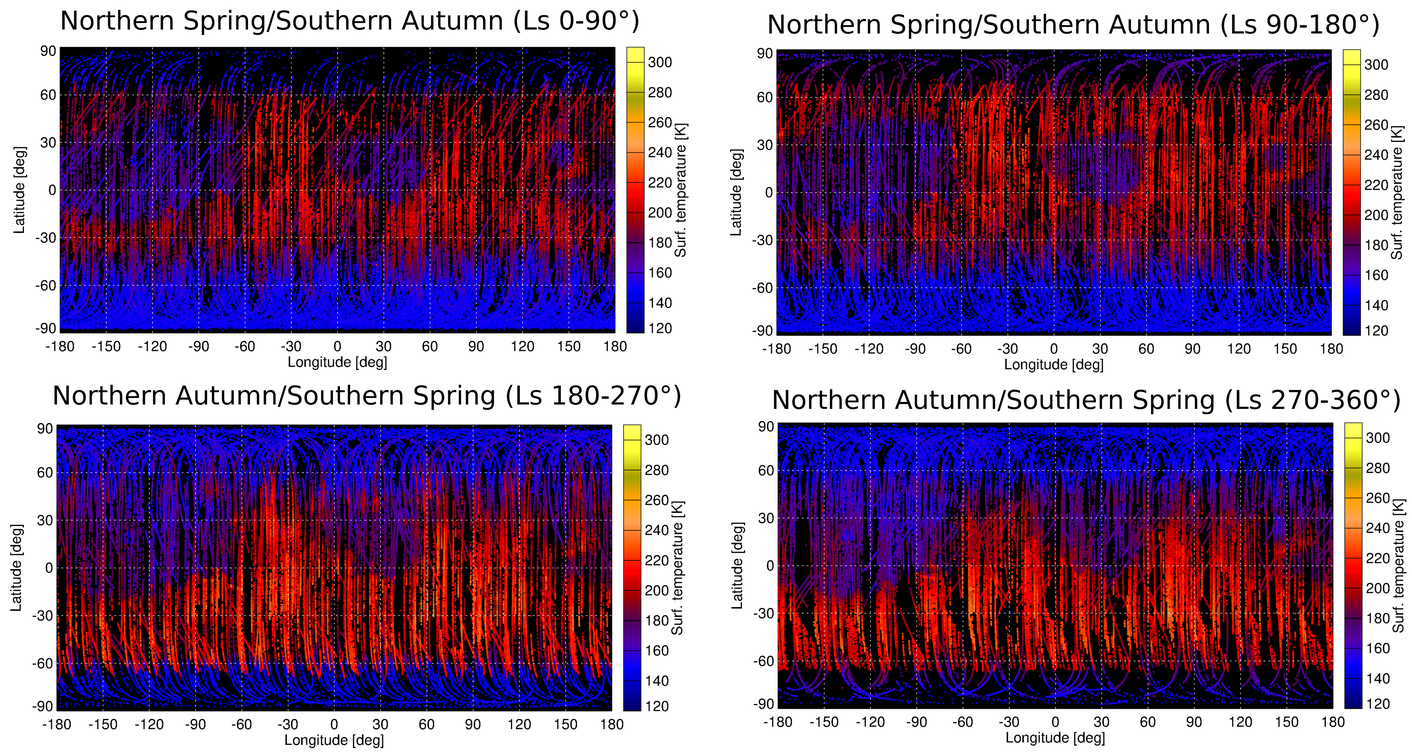

Figure 2. PFS/MEx nighttime surface temperature distribution on Mars in four different seasons from 9 martian years (MY26-34)

3. Results

Figure 4 shows that the PFS-based thermal inertia allows tracking seasonal retreat and advance of polar ice (Figure 4, bolded black lines). In the next step, we will discriminate between H_2O ice (2000-2500 tiu) and CO_2 ice (~1000 J m^{-2} $K^{-1}s^{-1/2}$). Due to phase transitions of CO_2 associated with latent heat in the early mornings and evenings and enhancing thermal inertia, CO_2 is easier to distinguish from H_2O ice using Differential ATI (DATI) approach [5] adjusted for Mars [3] and suitable for short-time intervals for example in late evening.

Monthly nighttime temperature changes

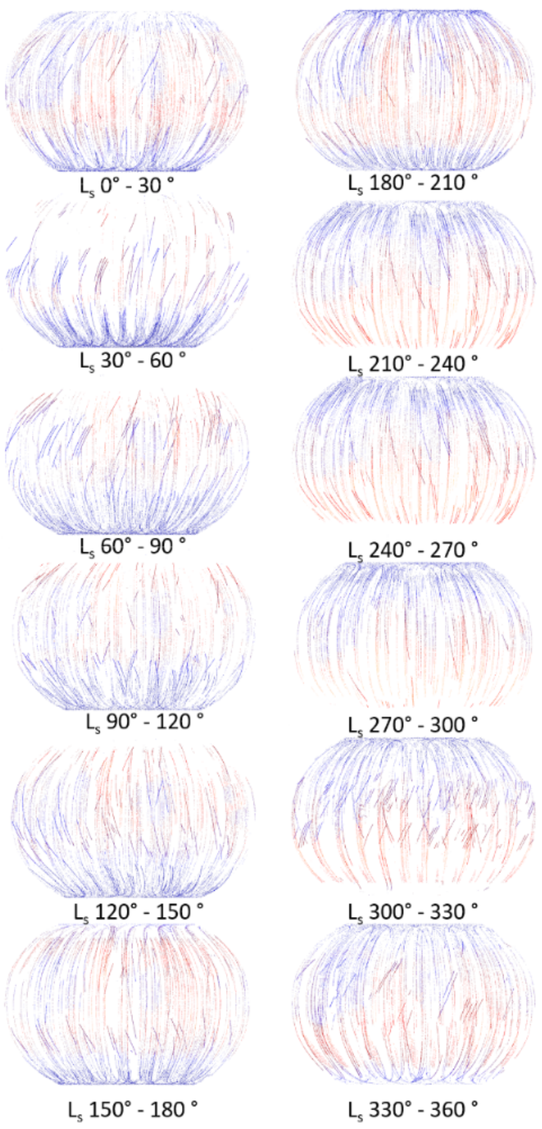

Figure 3. PFS/MEx nighttime surface temperature on Mars in 12 different time intervals from 9 martian years (MY26-34)

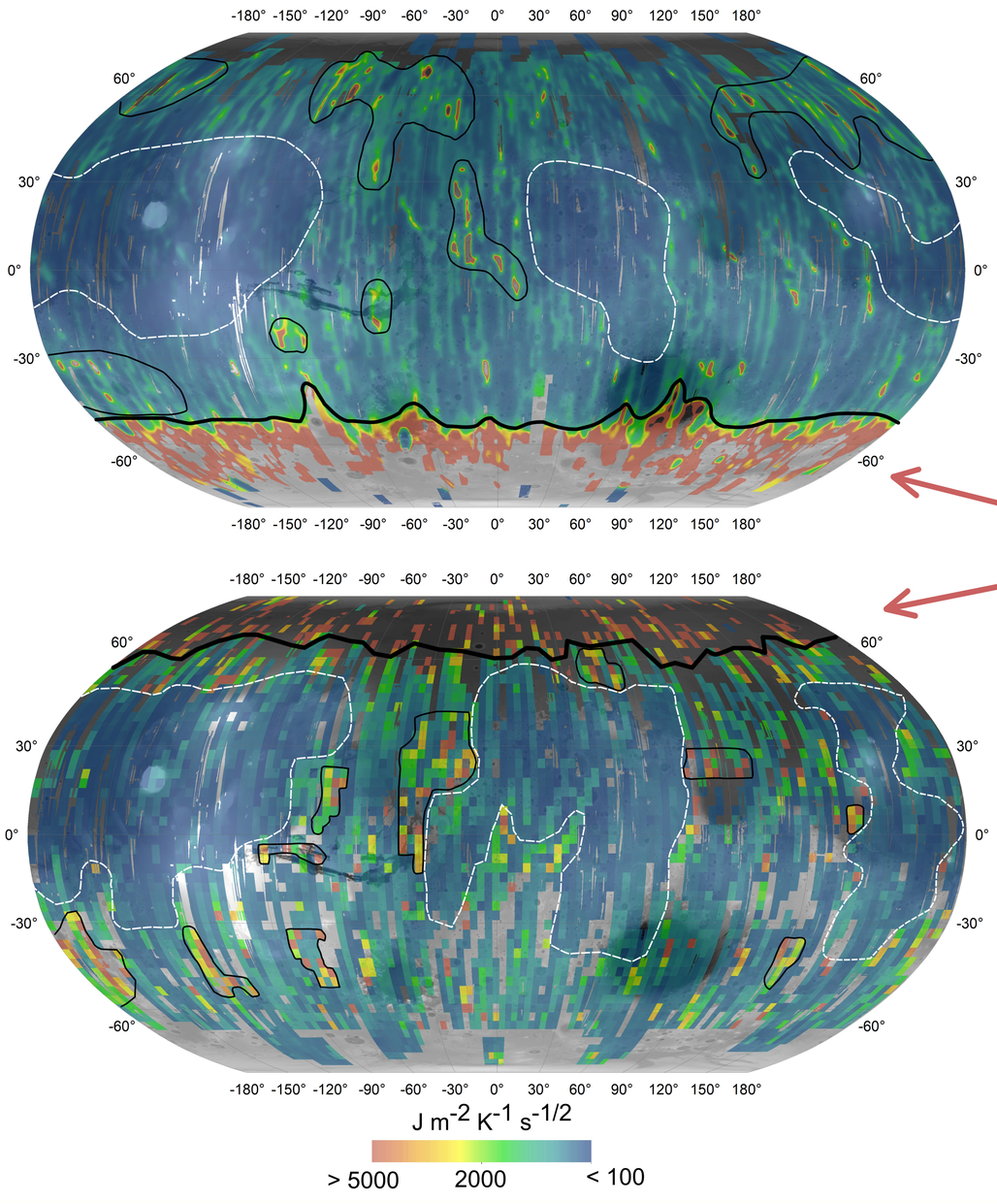

Figure 4. Thermal inertia maps for Ls=90°–150° (on top) and Ls=270°–330° (at the bottom) following ATI approach. The black lines indicate the the global boundary (along ~ 1000 J m^{-2} $K^{-1}s^{-1/2}$) between the high thermal inertia values interpreted as polar ice (the red domains) and the lower thermal inertia values representing martian soils (the blue domains)

Acknowledgements

This work was supported by the TEAM programme of the Foundation for Polish Science (projects TEAM/2011-7/9 and TEAM/2016-3/20), co-financed by the European Union within the framework of the European Regional Development Fund.

References

[1] Forget, F. (1998): Mars CO2 ice polar caps, Review chapter from Solar System Ices, 477-507, B. Schmitt et al. (eds.) Kluwer Academic, 1998. [2] Mellon, M.T., Fergason, R.L., and Putzig, N.E. (2008): The thermal inertia of the surface of Mars. In: J. Bell, ed., The Martian Surface: Composition, Mineralogy, and Physical Properties. Cambrige University Press, New York, ISBN: 978-0- 511-41372-8, 978-0-521-86698-9, 399-427. [3] Ciążela, M., Gurgurewicz, J., Ciążela, J., and Mège, D. (2019): High resolution thermal inertia mapping of sloping terrain on Mars: an Apparent Thermal Inertia-based method, in revision in Icarus. [4] Ody, A., et al. (2012): Global maps of anhydrous minerals at the surface of Mars from OMEGA/MEx, Journal of Geophysical Research: Planets, 118, doi:10.1029/2012JE004117. [5] 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. [6] Kubiak, M., Mège, D., Gurgurewicz, J., & Ciążela J. (2015). Thermal mapping of mountain slopes on Mars by application of a Different Apparent Thermal Inertia technique, EGU General Assembly, Vienna, Austra, 12-17.04.2015, abstract 1030.