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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

Abstract

Here, we track annual changes in the global surface ice distribution on Mars. We present apparent thermal inertia maps for the first time using the PFS/MEX (Planetary Fourier Spectrometer of Mars Express) surface temperature dataset.

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 tiu) compared to martian soils (<600 tiu) [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 9 successive Mars years (Ls=331° of MY26 to Ls=21° of MY34).

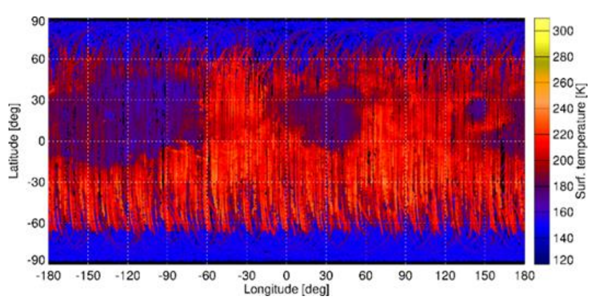

Figure 1. PFS/MEX nighttime surface temperature distribution on Mars averaged over 9 martian years (MY26-34).

2. Data and Methods

At first, we generated night-time temperature maps of Mars for 12 time intervals (months) to investigate thermal distribution changes over time (Figure 2). We then calculated thermal inertia maps for Martian summer (L_s=90°–150°) and winter (L_s=270° – 330°) using the apparent thermal inertia (ATI) approach [3]: $ATI=(1-A)/\Delta T$, where A is albedo and ΔT is temperature difference. We used the PFS night-time

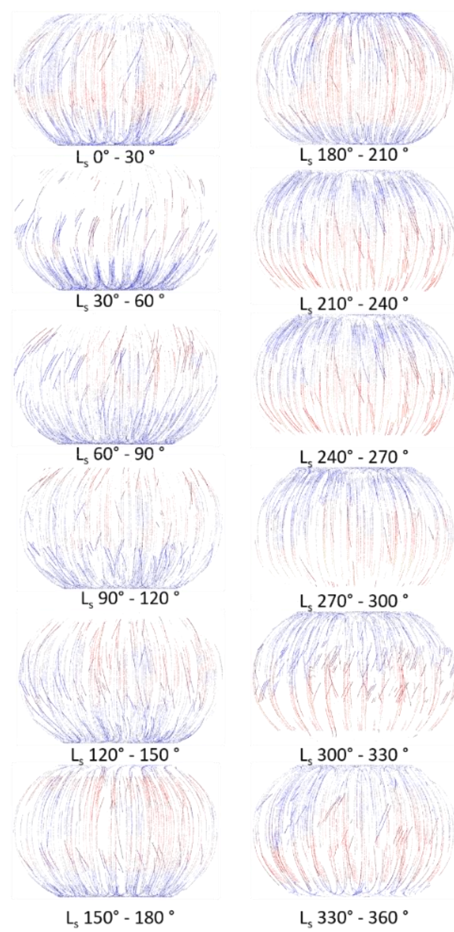

Figure 2. PFS/MEX nighttime surface temperature on Mars in 12 different time intervals from 9 martian years (MY26-34).

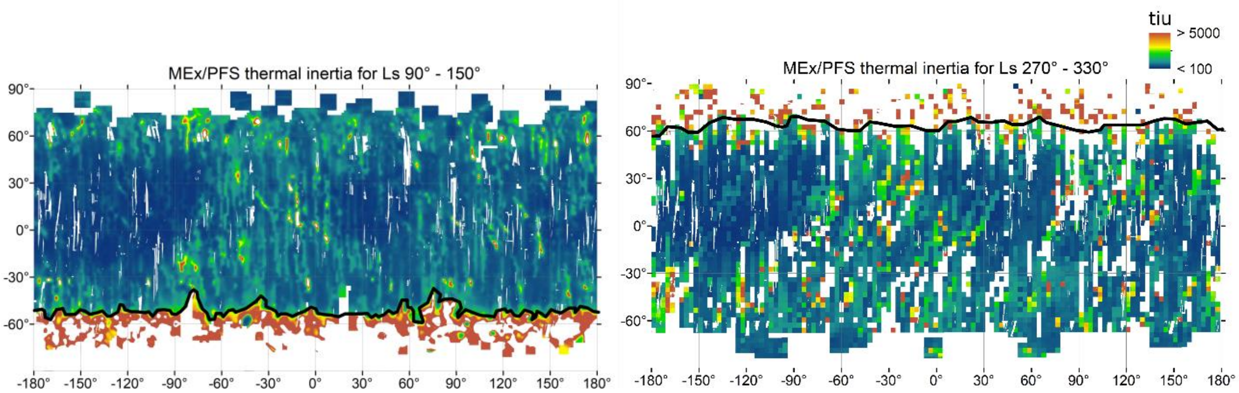

Figure 3. Thermal inertia maps (in tiu: J m^{-2} $K^{-1}s^{-1/2}$) for L_s=90° – 150° and L_s=270° – 330° following ATI approach [1]. The black lines indicate the global boundary (along ~1000 tiu) between the high thermal inertia values interpreted as polar ice (the red domains) and the lower thermal inertia values representing martian soils (the blue domains).

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 spectrometer from January 2004 to August 2010 [4].

3. Discussion

Figure 3 shows that the PFS-based thermal inertia allows tracking seasonal retreat and advance of polar ice (Figure 3, black lines). In the next step, we will discriminate between H_2O ice (2000-2500 tiu) and CO_2 ice (~1000 tiu). 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.

Acknowledgements

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