



HAL
open science

Martian atmospheric thermal structures and dust distributions during the global dust storm and the regional dust storm of MY 34 from ACS TIRVIM observations onboard ExoMars TGO

Pavel Vlasov, Nikolay Ignatiev, Sandrine Guerlet, Davide Grassi, Alexey Grigoriev, Alexey Shakun, Dmitriy Patsaev, Igor Maslov, Michail Luginin, Ehouarn Millour, et al.

► To cite this version:

Pavel Vlasov, Nikolay Ignatiev, Sandrine Guerlet, Davide Grassi, Alexey Grigoriev, et al.. Martian atmospheric thermal structures and dust distributions during the global dust storm and the regional dust storm of MY 34 from ACS TIRVIM observations onboard ExoMars TGO. Europlanet Science Congress 2021, Sep 2021, Virtual Meeting, Unknown Region. pp.EPSC2021-405, <10.5194/epsc2021-405>. <insu-04497292>

HAL Id: insu-04497292

<https://insu.hal.science/insu-04497292v1>

Submitted on 9 Mar 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Europlanet Science Congress 2021

Virtual meeting

13 September – 24 September 2021

[Home](#) > EPSC2021-405

EPSC Abstracts

Vol. 15, EPSC2021-405, 2021

<https://doi.org/10.5194/epsc2021-405>

Europlanet Science Congress 2021

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



Martian atmospheric thermal structures and dust distribution during the global dust storm and the regional dust storm from ACS TIRVIM observations onboard ExoMars Trace Gas Orbiter

Pavel Vlasov et al.

Abstract

Martian dust particles play an important part in radiative processes in Martian atmosphere, being involved in the energy balance on Mars [1]. The most significant manifestations of such cycles are dust storms which last several months and significantly affect the thermal structure of Martian atmosphere [2]. In addition to regular storms, global dust storms (hereinafter GDS) occur in several Martian Years (hereinafter MY) and cover the entire planet for months. GDS still remain a topic for scientific studies [3]. The latest global dust storm occurred in MY 34 and has been simultaneously monitored by the ExoMars Trace Gas Orbiter (TGO) [4].

In this paper we present results of analysis of thermal emission spectra of Mars measured with a Fourier Transform Infrared Spectrometer (TIRVIM) onboard TGO [5]. The main scientific goal of TIRVIM is long-term monitoring of temperatures and their distribution in Martian atmosphere in nadir mode of observations in the 5–16 μm spectral range [6]. Two observations were obtained in MY 34: the first one covered the first month of the GDS in a period from 26th of May 2018 to 26th of June 2018 (local season $L_s = 182.2^\circ$ – 211.7°), the second one lasted from 22nd of December 2018 till 18th of March 2019 and covered the regional dust storm (C-storm).

Retrieval of temperatures, dust and ice content from the thermal emission of Martian atmosphere in 15 μm range is one of a number of previous similar experiments [7, 8, 9]. We use iterative retrieval algorithm based on optimal estimation method. With TIRVIM spectral resolution $\Delta\nu = 1.17 \text{ cm}^{-1}$, temperature profiles may be retrieved from the surface to the vertical resolution in the order of few kilometers in the lower atmosphere. Spectral range from 780 to 1600 cm^{-1} contains absorption lines and is suitable for retrieving the temperature of Martian surface and column abundances of CO_2 and H_2O . Ice contents are defined as optical depths at wavelengths of local maxima of their spectral extinction cross-sections.

We have obtained the thermal structures of Martian atmosphere at various local times during the first month of the GDS and during the whole regional storm. We have compared temperature fields in the nighttime and daytime during the observed storms with structure of the pure dust atmosphere. Asymmetric heating with dust particles is a significant factor in the structure of the dust atmosphere.

is clearly seen in **Fig. 1**. Diurnal contrasts of temperature between nighttime and daytime are represented by excellent agreement with co-located MCS/MRO measurements [12], with the account for a worse vertical profile with TIRVIM.

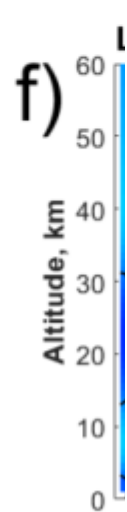
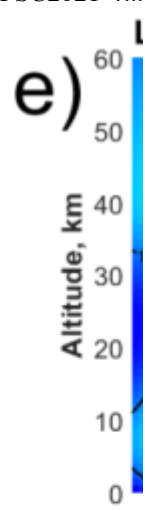
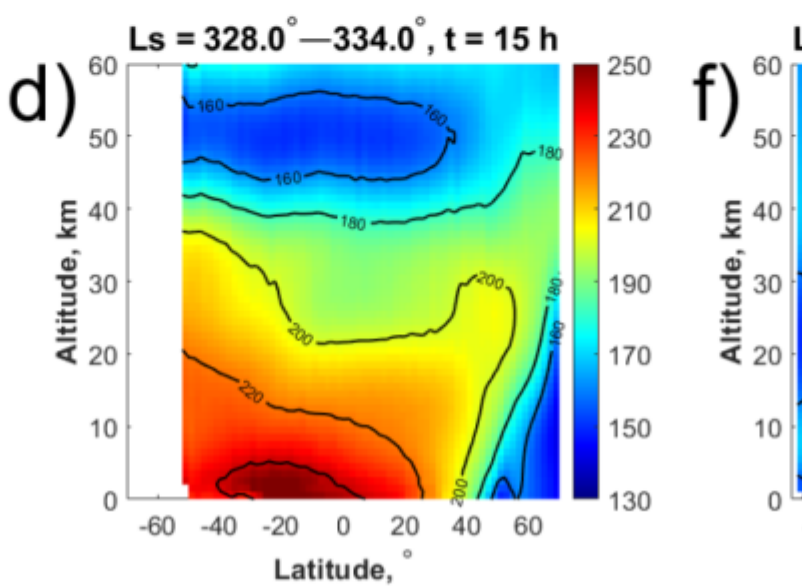
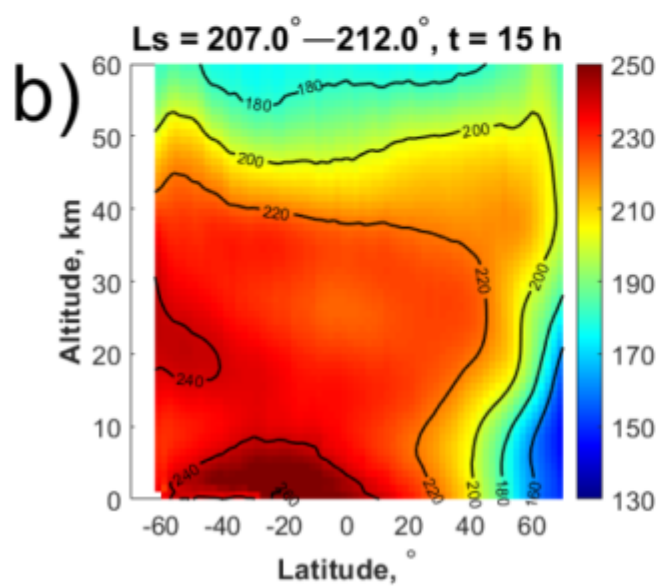
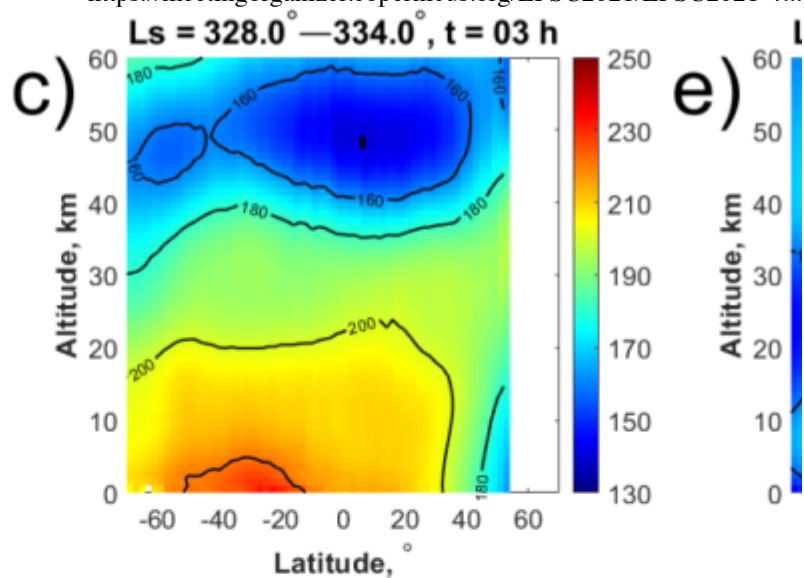
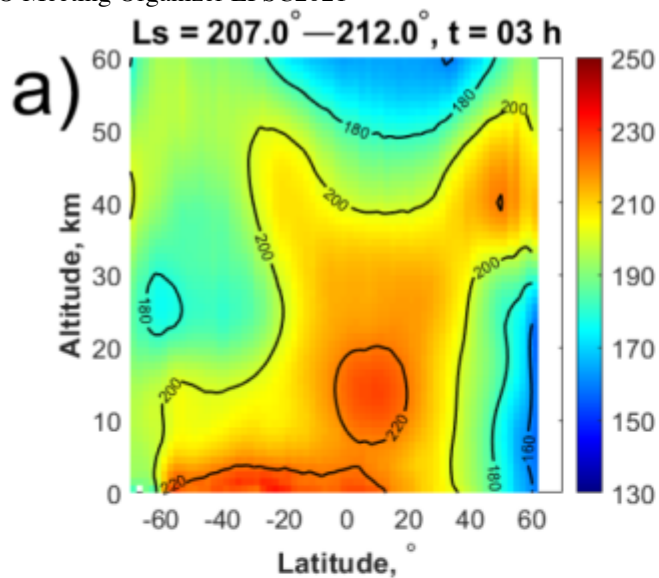
Along with the temperature field we also consider the variability of dust distribution during the distributions of dust in terms of column optical depth at 1075 cm^{-1} at the peaks of the global dust storm are shown in **Fig. 3**. Due to unavoidable degeneracy of the dust and ice retrieval problems at some temperatures contain also unreliable high and zero values of optical depth, which are to be filtered out.

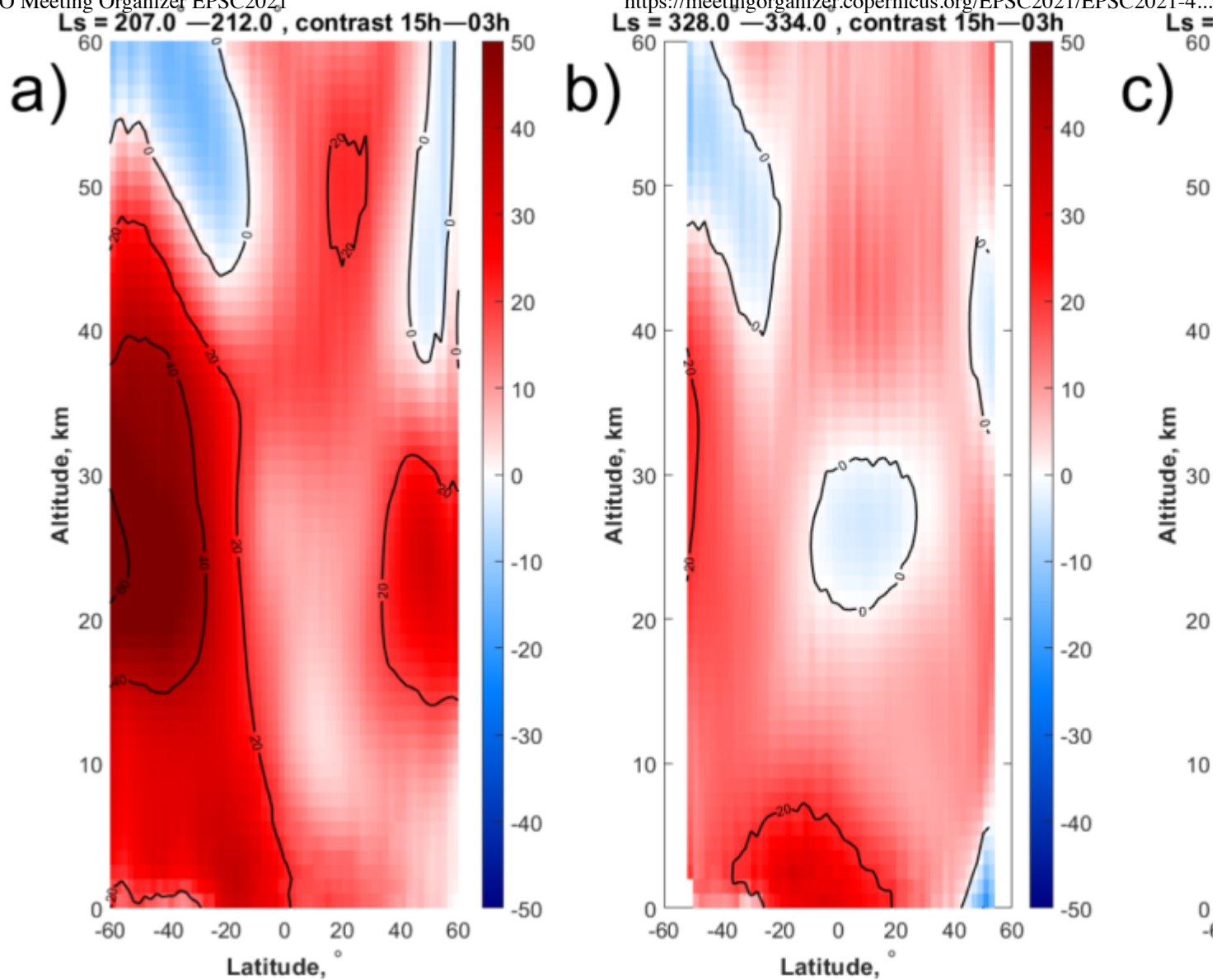
Acknowledgements

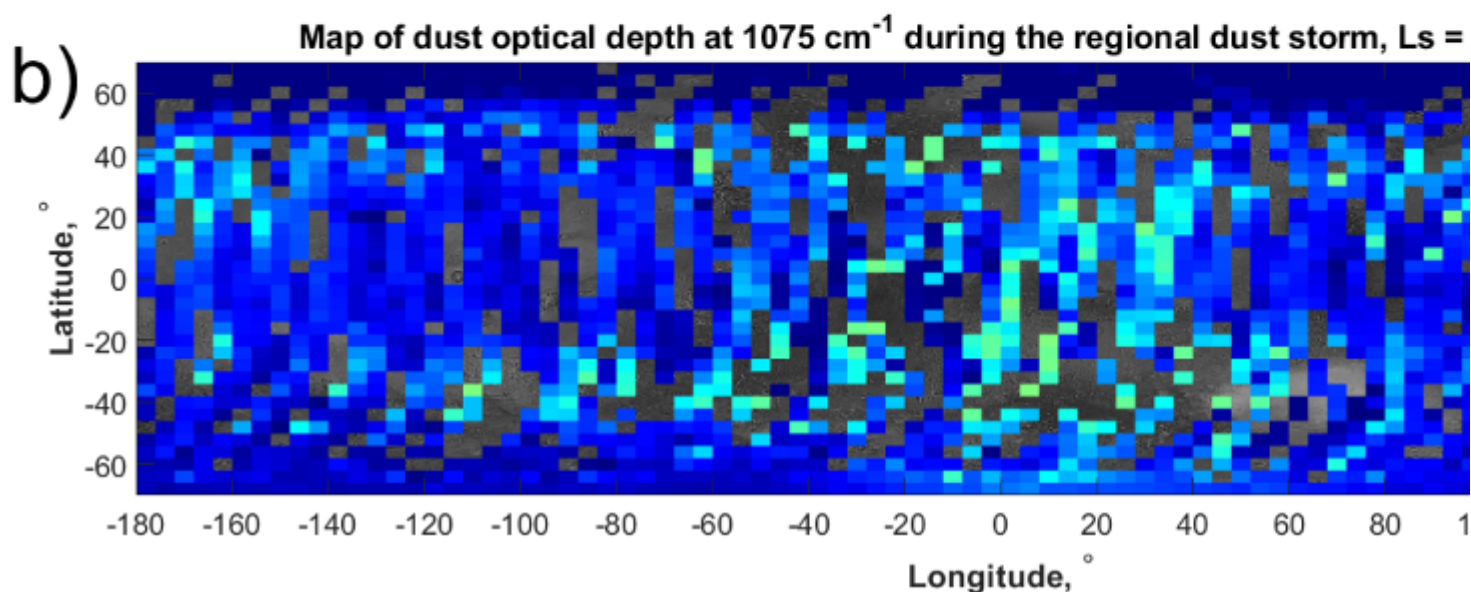
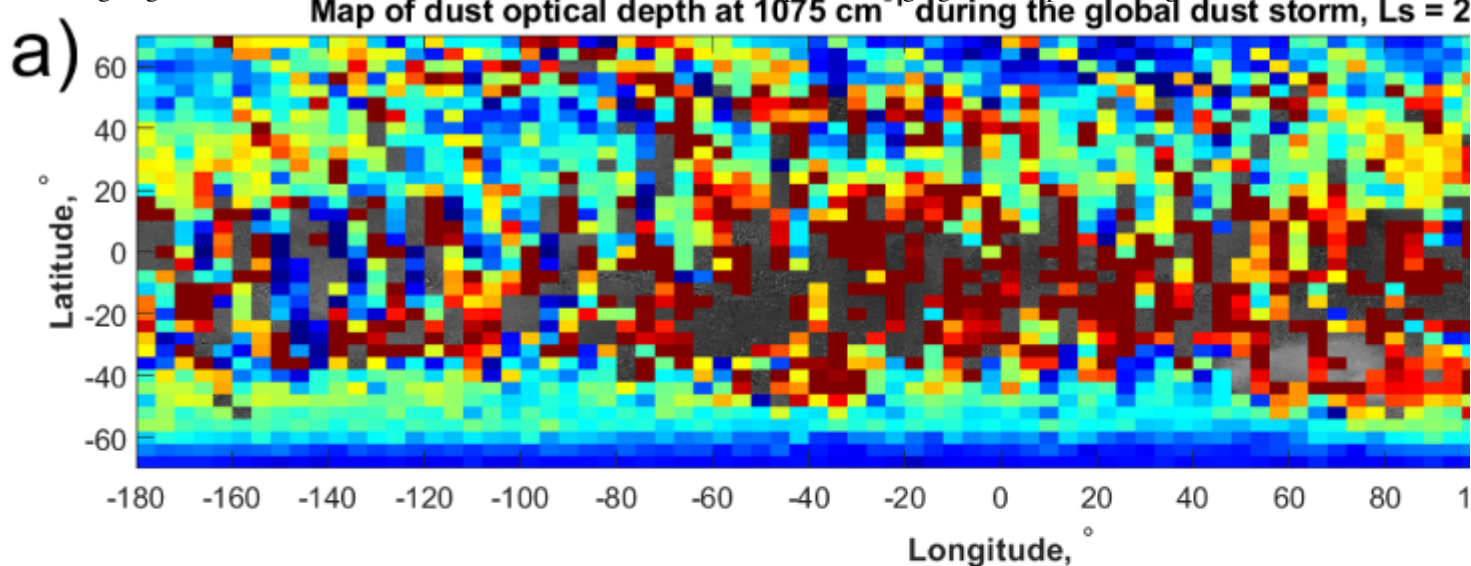
Science support in IKI is funded by the RSF grant #20-42-09035.

References

- [1] Kahre M.A. et al. The Mars dust cycle. The atmosphere and climate of Mars. // MA: Cambridge Univ.
- [2] Smith M.D. et al. Thermal Emission Spectrometer results: Mars atmospheric thermal structure and Geophysical Research. – 2001. – Vol. 106(E10). – P. 23929–23945
- [3] Zurek R.W., Martin L.J. Interannual variability of planet-encircling dust storms on Mars. // Journal of Geophysical Research. – Vol. 98(E2). – P. 3247–3259
- [4] Vago J. et al. ESA ExoMars program: The next step in exploring Mars. // Solar System Research. – 2018. – Vol. 52. – P. 103–110
- [5] Korablev O. et al. The Atmospheric Chemistry Suite (ACS) of Three Spectrometers for the ExoMars Science Reviews. 2018. Vol. 214.
- [6] Shakun A. et al. (2018). ACS/TIRVIM: Calibration and first results. // Proceedings SPIE 10765 Instrumentation XXVI, 107650E. – 2018
- [7] Zasova L. et al. The Martian Atmosphere in the Region of the Great Volcanoes: Mariner 9 IRIS Observations. // Space Science. – 2001. – Vol. 49. – P. 977–992
- [8] Smith M.D. et al. Separation of atmospheric and surface spectral features in Mars Global Surveyor (TES) spectra. // Journal of Geophysical Research. – 2000. – Vol. 105(E4). – P. 9589–9607
- [9] Grassi D. et al. The Martian atmosphere above great volcanoes: Early planetary Fourier spectrometry. // Space Science. – 2005. – Vol. 53. – P. 1053–1064
- [10] Conrath B.J. et al. Mars Global Surveyor Thermal Emission Spectrometer (TES) observations: A aerobraking and science phasing // Journal of Geophysical Research. – 2000. – Vol. 105. – P. 9509–9514
- [11] Clancy R.T., Wolff M.J. et al. Mars aerosol studies with the MGS TES emission phase function observations, and ice cloud types versus latitude and solar longitude. // Journal of Geophysical Research. – 2000. – Vol. 105. – P. 9515–9524
- [12] Kleinböhl A. et al. Diurnal Variations of Dust During the 2018 Global Dust Storm Observed by the Mars Global Surveyor. // Journal of Geophysical Research: Planets. – 2020. – Vol. 125.







How to cite: Vlasov, P., Ignatiev, N., Guerlet, S., Grassi, D., Grigoriev, A., Shakun, A., Patsaev, D., Masl Forget, F., Arnold, G., Trokhimovskiy, A., Korablev, O., and Montmessin, F.: Martian atmospheric thermal distributions during the global dust storm and the regional dust storm of MY 34 from ACS TIRVIM observations. Europlanet Science Congress 2021, online, 13–24 Sep 2021, EPSC2021-405, <https://doi.org/10.5194/e>

Contact

[Imprint](#)

[Contact](#)



Header image © Europlanet Society