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Thermal structure and aerosol content in the martian atmosphere from ACS-TIRVIM on board ExoMars/TGO

Sandrine Guerlet (1), Nikolay Ignatiev (2), François Forget (1), Thierry Fouchet (3), Alexey Shakun (2), Ehouarn Millour (1), Luca Montabone (4,1), Roland Young (1), Alexey Grigoriev (2), Alexander Trokhimovskiy (2), Franck Montmessin (5), and Oleg Korablev (2)

(1) Laboratoire de Météorologie Dynamique, LMD Tour 45-55 3eme etage BP99, Paris, France (sandrine.guerlet@lmd.jussieu.fr), (2) Space Research Institute (IKI), Moscow, Russia, (3) LESIA, Observatoire de Paris, Meudon, France, (4) Space Science Institute, Boulder, CO, USA, (5) LATMOS, Guyancourt, France

The ExoMars Trace Gas Orbiter (TGO), a mission by ESA and Roscosmos, was launched in March 2016 and reached its final, near-circular 400 km orbit around Mars in March, 2018. On board TGO, the Atmospheric Chemistry Suite (ACS) is a set of three spectrometers including a thermal-infrared channel, TIRVIM. This Fourier-transform spectrometer covers the range 600–6000 cm^{-1} (1.7–17μm) with a spectral resolution of 1.2 cm^{-1}. We focus here on nadir observations in the range 600-1300 cm^{-1}, which covers absorption by CO_2 (centered at 667 cm^{-1}), water ice clouds (centered at 820 cm^{-1}) and dust (centered at 1100 cm^{-1}). The advantage of the TIRVIM data set over previous instruments comes from the TGO orbit, which is not sun-synchronous and was designed to sample a complete daily cycle every 55 days. Hence, TIRVIM has the capacity to uniquely study both the diurnal and seasonal variability of the thermal structure, dust and ice cloud opacity.

We have developed a radiative transfer model coupled to a retrieval algorithm that exploits TIRVIM spectra to simultaneously retrieve vertical profiles of the temperature from 5 to 45 km, surface temperature, and integrated optical depth of dust and water ice clouds. This algorithm was tested and validated against synthetic observations generated under various conditions (local time, seasons, latitude, aerosol load, ...). We have then applied this algorithm to the first 45 days of TIRVIM data acquired in March-April, 2018. The retrieved temperature profiles have been validated against thousands of co-located measurements acquired by the Mars Climate Sounder around 3am and 3pm, a limb-viewing radiometer onboard Mars Reconnaissance Orbiter. The agreement between the two data sets is very satisfactory. In particular, the amplitude of the diurnal thermal tide as seen by MCS is very well captured by TIRVIM at pressures greater than 10 Pa. However, TIRVIM underestimates it in the range 1–10 Pa, which is due to a much poorer vertical resolution in this region (as expected from a nadir-viewing sounder). We will present these results with an emphasis on the diurnal cycle of the atmospheric temperature and the aerosols load, along with comparisons with predictions from the LMD Mars GCM. Analysis of TIRVIM data acquired during the dust storm in June-July 2018 is in progress and will also be presented.

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