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Mars dust microphysical properties retrieval through TGO/NOMAD UVIS and LNO channels combined nadir datasets analysis

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Abstract

In this work we analyze ExoMars/TGO NOMAD spectrometer [1] nadir data. We exploit both the ultraviolet-visible UVIS channel and the infrared LNO channel to obtain information about Martian dust densities and grains sizes. For the analysis we apply the MITRA radiative transfer tool [2,3,4] to all the spatially and temporally coincident UVIS and LNO 2018 data, also covering a global dust storm. We investigate possible correlations between the results and the local time of the observations.

Introduction

Studies focused on Mars 2018 global-scale dust event, as observed by the instruments on board the TGO spacecraft, demonstrate that Martian trace gases abundance and distribution is strongly affected by the presence of dust [5,6,15]. Airborne dust drives Mars' thermal structure and climate [7] by heating and cooling the lower atmosphere through absorption at VIS-NIR wavelengths [8] and emission in the IR range respectively [9,10,8,11]. These mechanisms affect, for example, the water-ice clouds formation and can drive convection, leading to variations of water vapor abundances [6,16]. In general, the understanding of dust properties is mandatory for the investigation of Martian trace gases vertical distribution.

Instrument and Observations

The NOMAD spectrometer has three channels covering the ultraviolet/visible (UVIS channel) and the infrared (LNO and SO channels) spectral ranges. While the instrument main focus is the study of trace gases, it can also be exploited to study atmospheric particulate. In this work, we take advantage of the combined UVIS and LNO channels data, acquired in nadir geometry, to study Martian dust microphysical properties. We analyze the whole 2018 dataset taking into account all observations that are spatially and temporally coincident among the two NOMAD channels, in order to build a dataset spanning from the ultraviolet/visible to the infrared spectral range.

Method

We use the MITRA radiative transfer model and inversion algorithm to retrieve dust microphysical properties from the selected dataset. The use of the combined ultraviolet/visible and infrared ranges, covered by UVIS and LNO NOMAD channels together, is required in order to separate the information related to the dust density from that of the grains sizes. However, if no coincident LNO observations are available for a certain UVIS orbit, we still apply the MITRA tool to the UVIS spectral range alone to obtain the dust integrated optical depth. We use only LNO orders covering the wavelength range 2.20-2.65 μm, since they are mostly affected by narrow and isolated gaseous absorption lines and, hence, they can be exploited to study the intensity of the spectral continuum. We take the temperature-pressure profiles from the Mars Climate Database (MCD, [12]) and use the dust optical constants from [13,14]. Surface albedo spectra are derived using an approach based on the SAS method [15] applied to the MEx/OMEGA dataset. The results of the retrieval are investigated for the identification of eventual trends of density and grains sizes with local time or other observing parameters.

Summary

The presented method allows to study Martian dust microphysical properties taking advantage of the combined UVIS and LNO NOMAD channels datasets. Given the reduced spatial coverage of the coincident data, we focus our analysis on the investigation of possible trends in the results with the observations local time. Once validated on 2018 data, the method is planned to be extended to the whole NOMAD dataset.

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