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Mars dust properties by means of TGO/NOMAD UVIS and LNO channels data analysis.

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Abstract

In this work we present an ongoing analysis of data collected by the UVIS and LNO channels of the *Nadir and Occultation for MArs Discovery* spectrometer (NOMAD, [1]), onboard the ExoMars *Trace Gas Orbiter* (TGO) spacecraft currently orbiting Mars. We will show how the two channels can be combined to obtain information about Martian dust densities and grains sizes. The retrieval of these properties is performed by means of the MITRA radiative transfer tool [2,3,4]. The method is validated on a NOMAD orbit registered during the 2018 global dust storm and its most critical issues are discussed.

1. Introduction

Martian dust can affect the abundance and distribution of atmospheric trace gases [5], whose investigation is fundamental to understand the atmosphere past evolution and provides insights on the research of biotic activities on the planet. Recent studies focused on the 2018 global-scale dust event as observed from the suite of instruments onboard the TGO spacecraft [6] highlight the role of dust as driver for the trace gases evolution. Indeed, suspended dust on Mars drives the planet's thermal structure and climate [7], heating the lower atmosphere through absorption in the VIS-NIR spectral range [8] and efficiently radiating heat to space through IR emission [9,10,8,11]. Considering the case of H_2O, for example, these heating and cooling mechanisms affect the water-ice clouds formation, strengthen the mean meridional circulation and can drive deep localized convection, leading to variations and redistributions of water vapour abundances [6]. For the above reasons, the understanding of dust properties is mandatory in order to correctly investigate the vertical distribution of Martian trace gases.

2. Instrument and observations

The NOMAD instrument is capable to observe with different pointing geometries taking advantage of three channels: UVIS, operating in the ultraviolet/visible range 0.2 – 0.65 μm, working both in nadir and solar occultation geometries; LNO, covering the infrared range 2.3 – 3.8 μm, working in nadir, limb and solar occultation geometries; SO, working in the range 2.3 – 4.3 μm and performing dedicated solar occultation measurements. Although NOMAD has been mainly conceived to study the trace gases in the atmosphere of the red planet, it can also provide valuable information regarding the properties of Martian dust. In this work we use the UVIS and LNO channels nadir data of orbit 045249 registered on the 8th of June 2018 during the global dust storm.

3. Method and Model

For the purpose of the analysis presented here we use only LNO orders from 175 to 202. These cover the wavelength range 2.20 - 2.55 μm which is approximately free from gaseous absorption and, hence, it is suitable to investigate dust properties. On the other hand, UVIS data are only used in the range 0.3 – 0.65 μm, where straylight contamination is negligible. The use of the two ranges together is mandatory in order to obtain both the dust density and size at the same time. Indeed, we show that while the order of magnitude of the dust optical depth can be roughly inferred from the UVIS data alone, dust grains sizes can be retrieved only by studying how the observed spectra bend between visual and near infrared wavelengths. Finally, we only use UVIS and LNO data overlapping on the same longitude and latitude coordinates and that are characterized by similar observation geometries. Once the composite UVIS and LNO spectra are constructed, we use the

MITRA radiative transfer model and inversion algorithm to retrieve dust densities and grain sizes. We derive the temperature-pressure profiles from the Mars Climate Database (MCD, [12]). We use the dust optical constants from [13]. The procedure to derive the surface albedo spectra needed in the forward model is based on the SAS method [14] applied to the OMEGA dataset. With such procedure, the albedo spectra are not available for all the NOMAD composite spectra, hence reducing the number of observations we analyze in this work.

4. Summary and future work.

We present a method to exploit the combined datasets of the UVIS and LNO channels of NOMAD to study the microphysical properties of Martian dust, allowing to obtain information on grains densities as well as their sizes. The method can be applied whenever spatially coincident UVIS and LNO (orders 175 through 202) observations are available. In this work we show the preliminary results of the method, applied to a single NOMAD orbit registered during the 2018 global scale dust storm. We plan to extend the analysis to other orbits as long as more coincident UVIS and LNO observations become available through the ongoing TGO mission.

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