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Martian aerosol-free reflectance spectra as input to better constrain atmospheric dust content in the NOMAD/TGO nadir observations

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Abstract

The Martian atmosphere is characterized by the presence of dust particles that during dust storms (global or regional) can reach opacities > 1. The aim of the present work is to identify and validate a strategy to better constrain atmospheric dust content in the NOMAD/TGO nadir observations making use of aerosol-free reflectance spectra derived from the OMEGA/MEX data set.

1. Rationale

NOMAD, the "Nadir and Occultation for MArs Discovery" experiment [1], is a suite of spectrometers on board the ExoMars Trace Gas Orbiter (TGO) mission that will operate in nadir, limb and solar occultation viewing modes. Nadir spectra will be collected by the Limb, Nadir and Occultation (LNO) and Ultraviolet and VIsible Spectrometer (UVIS) channels, covering respectively the 2.3-3.8 µm and the 0.2-0.65 µm spectral ranges. In the visible and infra-red ranges covered by NOMAD dust does not show well-defined absorption bands, although this indication is being tested by other members of the NOMAD team. Airborne dust particles can increase/decrease the albedo for dark/bright terrains and introduce specific slopes depending on opacity and grain size. Surface reflectance in aerosol-free conditions is thus a crucial parameter in the retrieval codes used to assess the dust content in nadir viewing mode. The OMEGA (Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité [2]) instrument on boarda the Mars Express mission investigated Martian surface properties on a global scale between 0.4-5.1 µm in nadir-pointing geometry and provide a valuable dataset to derive reflectance spectra of the surface in dust-free conditions [e.g. 3].

2. Method

Figure 1 shows two spectra from OMEGA sessions collected in two different seasons but covering the same location (LON= 68.6°E, LAT =15.9°N).

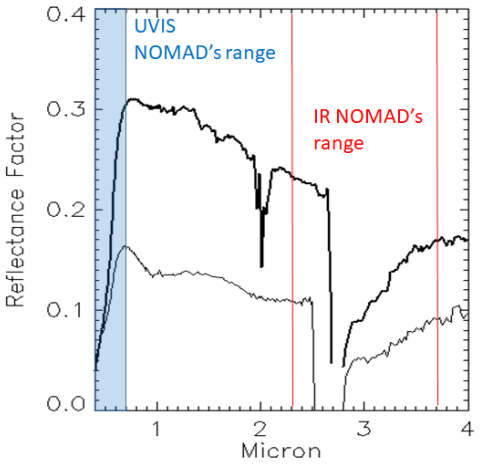

Figure 1: An example of OMEGA spectra, showing the overlap with NOMAD ranges.

The thin spectrum represents the atmosphere corrected reflectance retrieved from the OMEGA session ORB2458_5 using the SAS (Surface

Atmosphere Separation) method [3]. Here, atmospheric features (dust and CO_2 absorptions at 1.5 μm and 2.2 μm) have been removed. The thick spectrum has been measured at the same location during the OMEGA session ORB4558_4 but presents a higher dust content. It represents the top of dusty atmosphere, showing the CO_2 atmospheric features as well. For the dusty spectrum, opacity of the order of 3 has been estimated by means of the method described in [4], using the thin spectrum as input for the surface in dust-free conditions.

3. Summary

Aerosol-free reflectance spectra derived from the OMEGA data set can be used as input for the surface reflectance into NOMAD retrieval codes. Uncertainties due to the different spectral ranges covered by NOMAD and OMEGA will be evaluated and reported in this work. Water ice cloud effects will be also investigated. Improvements in the aerosol properties gathered thanks to NOMAD limb/occultation measurements will be taken into account.

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