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Introduction:

Aerosols present in the atmosphere of Mars have a major effect on it. They are mainly composed of dust, water ice or CO_2 ice. Dust is confined to lower altitudes during the aphelion season and can reach higher altitudes during the perihelion, especially during dust storms that frequently arise on Mars. These storms can sometime grow up to cover the entire planet and are then called a global dust storm.

The NOMAD ("Nadir and Occultation for MArs Discovery") spectrometer suite on board the ExoMars Trace Gas Orbiter (TGO) is composed of three spectrometers, two in IR (LNO and SO) and one in UV-visible (UVIS). The UVIS channel spectral range extends from 200nm to 650nm with a spectral resolution about 1.5nm. UVIS can operate in nadir and occultation modes. In this work, we use observations taken in occultation mode to investigate the vertical distribution of aerosols.

Method:

To compute aerosol’s extinction, from the transmittances of UVIS. We use first the ASIMUT code (Vandaele, et al., 2006.) to make a fit on ozone and Rayleigh scattering and then subtract them from the original transmittances. In the result should remain only the background of the spectra. Extinction can be computed from the transmittance after subtraction of ASIMUT’s fit using the formula from (Wilquet et al., 2012): *)* and *(*. With τ the optical depth , T the transmittance, I the solar irradiance attenuated through the atmosphere and I_0 the reference irradiance of the solar spectrum outside the atmopshere. β represents the extinction and N the number of layer above the current layer n. λ represents the wavelength and dZ represents the pathlength of light through the atmosphere to the point and i represent the upper layer.

The extinction is fitted using the refractive index for Mars dust from (Wolff et al., 2009). The extinction efficiency, Q_{ext} is computed using a Mie code (Bohren, et al., 1998) with a log normal size distribution. Given the Q_{ext} for each size distribution, the number density ”n” is fitted using the relation $\beta = n * Q_{ext}$, with β the extinction derived from the UVIS spectra. The fit is made for each effective radius and each standard deviation. The best fit finally selected will be the one with the smallest reduced chi square. The number density error is calcultated based on the extinction error with a Monte Carlo algorithm.

Results:

Using only the spectral range of UVIS, the dust, water ice and CO_2 ice cannot be differentiated because the three aerosols have similar spectral features in the UV-visible. Therefore, only dust will be assumed in this work. Detection of CO_2 and water ice will be investigated in a future work. Dust in the Martian atmosphere is sensitive to seasonal variations. During perihelion (LS 250), the atmosphere of Mars becomes warmer, and dust can be transported to higher altitudes. In the contrary, at the aphelion (LS 70) dust remains confined at lower altitudes.

Figure 4: Dust vertical extinction profiles versus solar longitude for Mars year 34 to 36

We can see on Figure 4 that at the perihelion dust is present at higher altitudes and the extinction is stronger than during the aphelion. In this work we will further compare the vertical distribution of dust for Mars year 34 (with global dust storm) and Mars year 35 (without global dust strom), as well as latitudinal variations.

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References:

Bohren, Craig F. and Donald R. Huffman,Absorption and scattering of light by small particles, New York : Wiley, 1998, 530 p., ISBN 0-471-29340-7, ISBN 978-0-471-29340-8 (second edition)

Vandaele, A.C., Kruglanski, M., Mazière, M.D., n.d. MODELING AND RETRIEVAL OF ATMOSPHERIC SPECTRA USING ASIMUT 6.

Wilquet, V., Drummond, R., Mahieux, A., Robert, S., Vandaele, A.C., Bertaux, J.-L., 2012. Optical extinction due to aerosols in the upper haze of Venus: Four years of SOIR/VEX observations from 2006 to 2010. Icarus 217, 875–881. https://doi.org/10.1016/j.icarus.2011.11.002

Wolff, M.J., Smith, M.D., Clancy, R.T., Arvidson, R., Seelos, F., Murchie, S., Savijärvi, H., 2009. Wavelength dependence of dust aerosol single scattering albedo as observed by the Compact Reconnaissance Imaging Spectrometer. J. Geophys. Res. 114, E00D04. https://doi.org/10.1029/2009JE003350