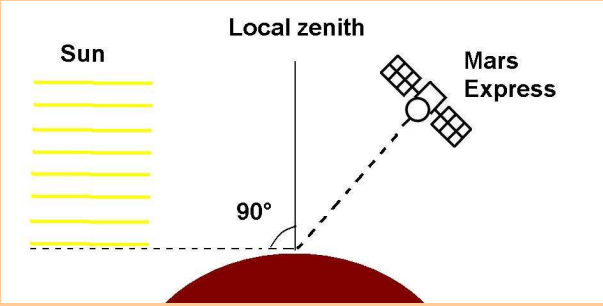
Martian atmospheric ozone column content and dust optical depth retrieved from SPICAM nadir measurements in twilight conditions.

N. Mateshvili (1,2), D. Fussen (1), G. Mateshvili (2), I. Mateshvili (2), F. Vanhellemont (1), E. Kyrölä (3), S. Tukiainen (3), J. Kujanpää (3), C. Bingen (1), C. Robert (1), C. Tétard (1), E. Dekemper (1), N. Loodts (1), and T.Paatashvili (2)
(1) Belgian Institute for Space Aeronomy, Brussels, Belgium (ninam@aeronomie.be) (2) Abastumani Astrophysical Observatory, Ilia State University, Georgia, (3) Finnish Meteorological Institute, Helsinki, Finland

BIRA·IASB aeronomie·be

1.Introduction.

SPICAM is an ultraviolet-infrared spectrometer onboard the Mars Express satellite. SPICAM UV channel wavelength domain covers the ozone Hartley band what allows to retrieve ozone content spatio-temporal distribution from nadir measurements. Perrier et al.,(JGR,2006) retrieved ozone content from SPICAM nadir measurements in plain parallel atmosphere approximation, excluding parts of orbits where solar zenith angles (SZAs) were larger than 85º. In this paper ozone content and dust optical depth are retrieved from SPICAM nadir measurements at SZAs 88-90º in the spherical atmosphere approximation (**Fig.1,** below). Ozone and dust retrieval from measurements acquired in twilight conditions extends the spatial and temporal coverage what is especially important for polar regions in winter periods. Another advantage is a possibility to neglect the surface albedo contribution what is important because the surface albedo and atmospheric dust have very similar spectral signatures in the UV and it is difficult to separate their contributions correctly.



The **Monte Carlo code Siro** (Oikarinen et al., JGR,1999) was adapted for Martian atmosphere and used to construct a forward model.

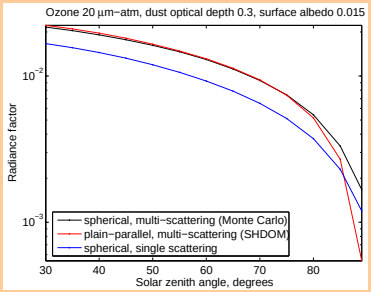


Fig. 2 (right) shows a comparison between three radiative transfer codes outputs: fully spherical Monte Carlo simulation (black), plain-parallel multi-scattering radiative transfer code SHDOM (red) and single-scattering spherical radiative transfer code (blue). When the solar zenith angle exceeds 80°, the effects of sphericity turn to be not negligible.

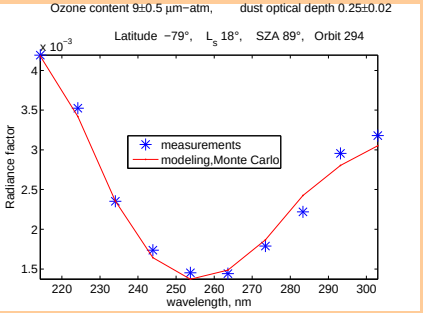


Fig. 3 (left) shows an example of a measured SPICAM spectrum (blue asterisks) and the modeled one (red line). The ozone content and the dust optical depth used for modeling were retrieved from the SPICAM twilight spectrum applying the Levenberg-Marquardt method.

2. Forward model input parameters and limitations.

Two parameters – the column ozone content and the dust optical depth were retrieved. The surface albedo assumed to be a constant value because it contributes only in multiple scattering in twilight conditions and the radiance factor variations due to the surface albedo variations are within the limits of the measurement uncertainties.

The atmospheric surface pressure, temperature profile and ozone volume mixing ratio (mol/mol) were taken from the Mars Climate Database (Forget et al.,1999).

The retrieved value of the column ozone content strongly depends on the assumed ozone profil. **Fig. 4**(below) shows two very similar SPICAM spectra acquired during orbits 1596 (blue asterisks) and 5246 (red asterisks). The spectra were fitted using the corresponding ozone profiles (volume mixing ratio, mol/mol) presented in the inset. The spectra were modeled(red and blue lines) using the retrieved ozone content. The spectrum acquired during the orbit 5246 was modeled ones more (green line) using the ozone profile that corresponds to the spectrum acquired during the orbit 1596. The change of the ozone profil strongly modified the modeling results.

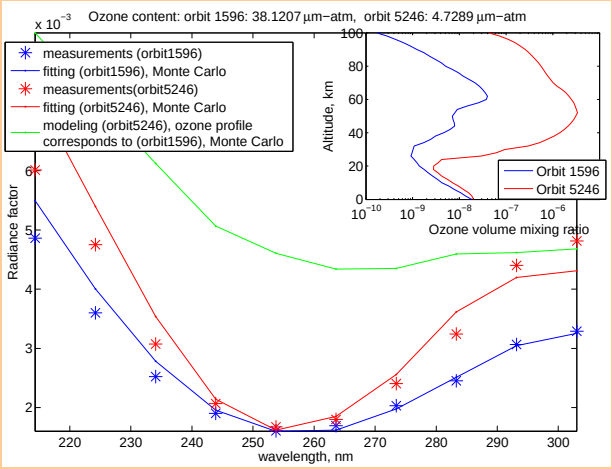
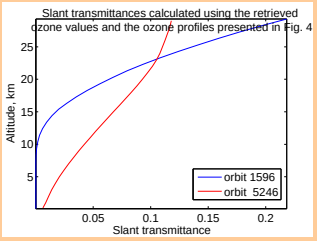


Fig. 5 (right) shows the slant path transmittances calculated for two SPICAM spectra presented in Fig. 4. In case of the high ozone content in the lower atmospheric layers they become fully opaque and the retrieval algorithm turns to be not sensitive to further ozone content increase in the layers.



We conclude that the ozone profile uncertainties can bring a very important uncertainty in the retrieved value of th column ozone content. To reduce the uncertainty of the retrieved column ozone content, the ozone profile was scaled using the retrieved ozone column. The scaled profile was integrated above 10 km altitude.

3. Ozone and dust maps

Below we present ozone column contents above 10 km (**Fig.6**) and dust vertical optical depths (**Fig.7**) retrieved from SPICAM nadir measurements in twilight conditions. The retrieved values correspond to the expected ozone and dust spatio-temporal distributions.