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Optical properties of the Martian aerosols as derived from Imager for Mars Pathfinder midday sky brightness data

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1. Introduction

It is well known that the aerosol play a major role in the energy budget of the Martian atmosphere. The importance of the aerosols for the radiative loading of the atmosphere has hence, direct impact on the Martian present weather and its seasonal cycle as well as consequences for its long term climate. Very accurate models of the sky brightness are required to separate the atmospheric illumination from the spectrum of the Martian surface, and hence to understand the mineralogy of the surface rocks and soil. Such accurate models are only possible if the optical properties of the Martian aerosols are known. In this work we analyze the images of the brightness of the Martian sky at midday acquired from the surface of the Mars during the Mars Pathfinder mission.

The Imager for Mars Pathfinder (IMP) obtained data in filters centered at 443.6, 481.0, 670.8, 896.1 and 965.3 nm. Useful data sets were returned on sols 27, 40, 56, 65, 68, 74 and 82. Although the coverage in scattering angles of this sequence is limited to about 100°, having the Sun near zenith minimizes multiple scattering. This property should help in accuracy of constraining the size distribution and material properties. The shape of the particles can be expected to be less well constrained, as scattering events at angles around 150° are only present through multiple scattering. Data from sol 56 (Figure 1) were fitted with multiple scattering radiative transfer calculations to extract the size distribution, optical properties, and shape of the aerosols suspended in the atmosphere [1].

2. Results of modeling

The derived effective radius of the particles was found to be r_{eff} = 1.71 +0.29/-0.26 μm with an effective variance of ν_{eff} = 0.25 +0.05/-0.1 [1]. The derived single-scattering phase function was more compatible with plate (clay) like particles rather than equal dimensional particles. The analysis by [1] assumed a simple single-component dust atmosphere. The data-model residuals exhibited, albeit weak, wavelength dependence (Table 1). This dependence can be interpreted as an indication that during the time the analyzed images were taken, the dust particle distribution was bimodal or that the Martian atmosphere contained a second component, possibly submicron ice particles, in the aerosol's population. Here we will present the analysis of the data from the remaining 5 sols.

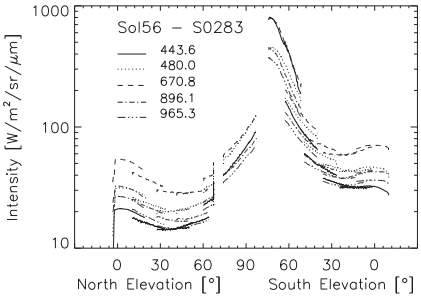

Figure 1: The complete set of pre-calibration data from sequence S0283 obtained on sol 56. Curves are labeled by center wavelength of the filter.

Table 1: The optical depth and single scattering properties derived from sol 56 data.

λ, nm	443.6	481.0	670.8	896.1	965.3
τ	0.56	0.60	0.59	0.61	0.60
r_{eff}	1.45	1.66	1.60	1.85	2.00
ν_{eff}	0.28	0.30	0.15	0.25	0.26
Q_{ext}	2.80	2.84	3.00	3.10	3.20
Q_{sca}	2.09	2.30	2.80	2.89	3.07
$< \cos\theta >$	0.77	0.75	0.73	0.74	0.72
θ_{min},°	170	140	160	220	230
b	0.042	0.051	0.052	0.046	0.044
n_i	0.0150	0.0090	0.0032	0.0038	0.0024

References

[1] Markiewicz, W. J., et al.: JGR, Vol. 104, No. E4, pp. 9009–9017, 1999.