

3 MARS YEARS OF DUST OPTICAL DEPTH MAPPING BY OMEGA ABOVE THE SOUTH POLE. M. Vincendon¹, Y. Langevin², S. Douté³, J.-P. Bibring², ¹Department of Geological Sciences, Brown University, Providence, Rhode Island, 02912, U. S. A. (mathieu_vincendon@brown.edu). ²Institut d'Astrophysique Spatiale, Orsay, France. ³Laboratoire de Planétologie de Grenoble, Grenoble, France

Introduction: The varying amount of airborne dust particles observed at high latitudes directly affects the polar energy balance of Mars [1]. The behavior of aerosols above the south polar cap differs from that seen in equatorial and mid-latitude regions ([2], [3], [4]). It can however not be determined by classical thermal infrared methods of optical depth retrieval as the thermal contrast between surface ice and atmosphere is too low [5]. The strong near-IR absorptions of CO₂ ice enabled the development of a new method to retrieve optical depths which requires the presence of clean CO₂ ice at the surface [4]. We have extended the application of this method to 2007 and 2009 springs and summers and compared the results to the 2005 retrievals presented in [4]. This new time range includes the planet-encircling dust event of July 2007. Modeling results which aim at determining the amount of deposited dust during this global dust storm will also be presented at the conference.

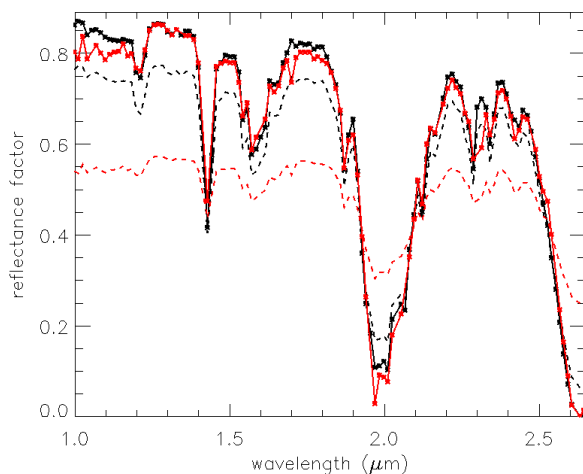


Figure 1: The CO₂ covered surface at 301°E and 84°S is observed by OMEGA in 2005 (black dotted line, moderate opacity period) and 2007 (red dotted line, beginning of the global dust storm) at the same L_S (272°). The observed spectral contrast is significantly reduced during the dust storm. The reflectance at 2.64 μm is used [4] to estimate the optical depth of dust aerosols: 0.4 in 2005 compared to 1.7 in 2007. Using this optical depth to correct observations from aerosols scattering leads to very similar surface spectra (solid lines), which validates the method in case of very high opacities.

Method: The reflectance observed by OMEGA at 2.6 μm has been demonstrated to be uniquely due to the light scattered by the whole layer of aerosols when clean CO₂ ice covers the surface (Figure 1). We can therefore convert this reflectance to an optical depth of dust particles using a RT code [4].

Results: The time variations of the optical depth above the South Pole are presented in Figure 3 for three martian years. They show a high level of consistency in the L_S 180°-250° range. As the summer solstice approaches, optical depths are strongly affected by the dust events occurring at equatorial latitudes: the increase of optical depth seen by Opportunity at L_S 315° in 2005 [6] propagates up to the south pole, as well as the 2007 planet encircling dust event (L_S 265°).

While a significant part of OMEGA low to mid latitude observations show no evidence for persistent surface dust deposits during the months following the decay of the 2007 planet encircling dust event [7], evidence for the deposition of a thin layer of dust above the south cap have been obtained (Figure 2). After L_S 292° a significant decrease (10/15%) of the ice albedo is observed in MY28 compared to MY27. This change can not be attributed to aerosols or photometric conditions which are alike. As the spectral properties of ice are similar in MY27 and MY28 before the storm (Figure 1), we attribute this change to the deposition of a thin layer of dust. The amount of dust deposited at the surface will be estimated using the model of [8].

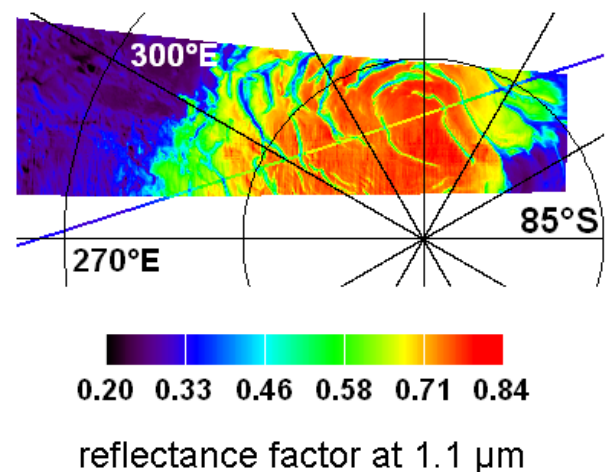


Figure 2: Comparison of OMEGA observations of the south cap at L_S ~ 293° obtained in 2005 and

2007 (observed albedo map: $I/F/\cos(i)$ at $1.1 \mu\text{m}$). A thin track obtained in 2007 overlaps a large track obtained in 2005. The conditions of observations are similar (photometric angles and aerosols optical depth).

References: [1] Paige et al. (1994), *J. Geophys. Res.*, 99, 25,993-26,013. [2] Neumann et al. (2003), *J.*

Geophys. Res., 108, 5023. [3] Montmessin et al. (2006), *J. Geophys. Res.*, 111, E09S09 [4] Vincendon (2008), *Icarus*, 196, 488, 505. [5] Smith (2004), *Icarus*, 167. [6] Lemmon (2006), *Lunar Planet. Sci. Conf.* 37, #2181. [7] Vincendon et al. (2009), *Icarus*, 200, 395-405. [8] Douté and Schmitt (1998), *J. Geophys. Res.*, 103(E13), 31,367-31,390

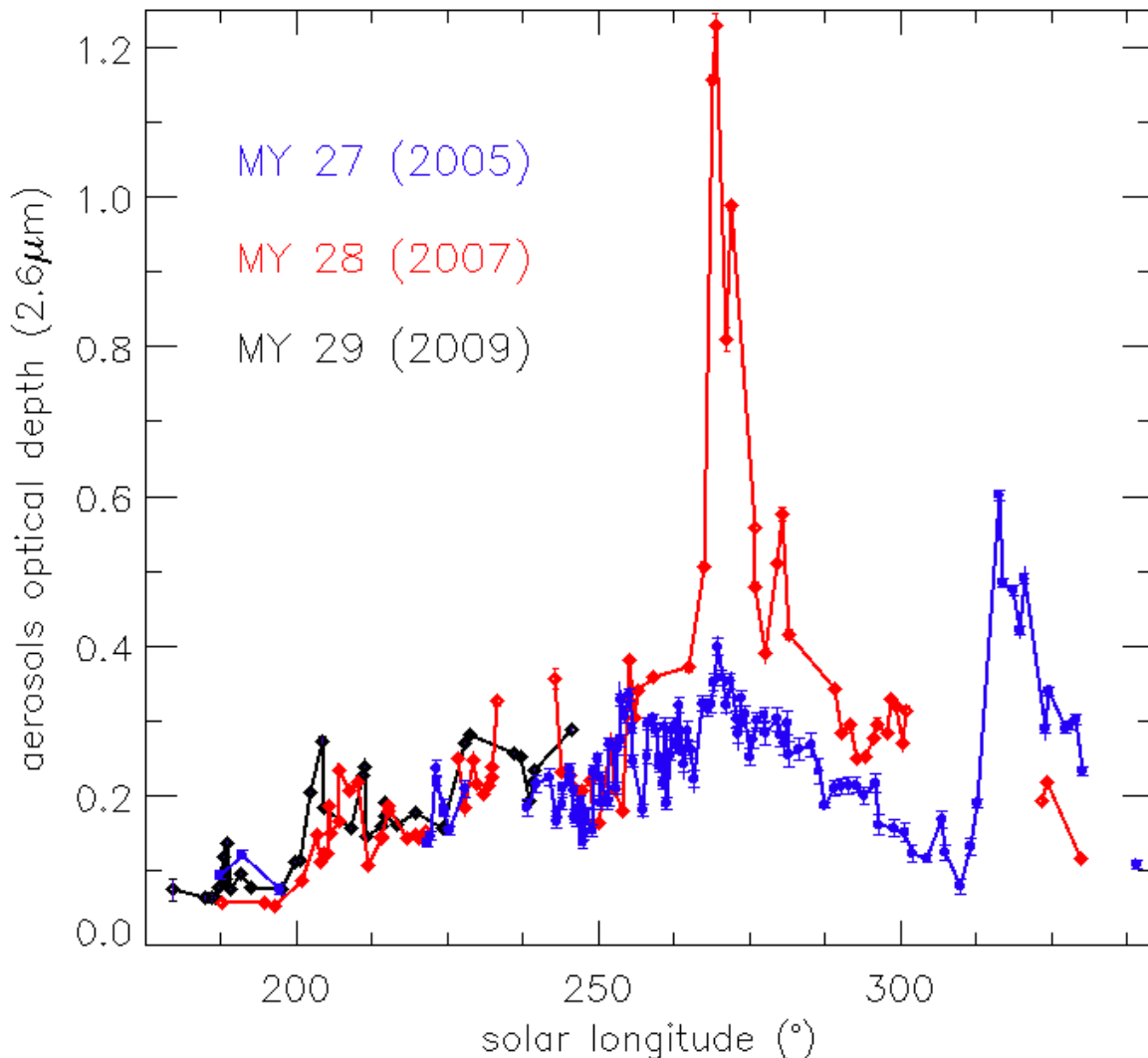


Figure 3: Time variations of the optical depth of dust aerosols during southern spring and summer as seen by OMEGA during 3 Mars Years (MY27 in blue – from [4], MY28 in red and MY29 in black). The $2.6 \mu\text{m}$ normal optical depth of the whole aerosols layer is derived from OMEGA observations above the south cap summit at 87°S , 355°E . Relative error bars are indicated. See [4] for a discussion of the absolute uncertainties (estimated to be reduced to a multiplicative factor in the [1. – 1.3] range).