EPSC Abstracts
Vol. 11, EPSC2017-527, 2017
European Planetary Science Congress 2017


# Properties of a Martian local dust storm in Atlantis Chaos by means of OMEGA/MEX data analysis

F. Oliva, A. Geminale, E. D'Aversa, F. Altieri, G. Bellucci, F.G. Carrozzo, G. Sindoni.

INAF-IAPS, Rome, Italy (fabrizio.oliva@iaps.inaf.it)

## Abstract

In this study we present the analysis of the dust properties of a local storm imaged in the Atlantis Chaos region on Mars by the OMEGA imaging spectrometer on March 2nd 2005. We use the radiative transfer model MITRA to study the dust properties at solar wavelengths between 0.5 µm and 2.5 µm and infer the connection between the local storm dynamics and the topography. We retrieve maps of effective grain radius ($r_{eff}$), optical depth at 9.3 µm ($\tau_{9.3}$) and top altitude (*ta*) of the dust layer. Moreover, we discuss about the region where the storm originated. Finally, we deduce that the 5 µm transmission window can be reliably used to sound the temperature of the surface only for $\tau_{9.3} < 1$.

## 1. Introduction

The study of suspended dust on Mars is fundamental to understand the planet's thermal structure and climate [6]. Martian aerosols are mainly made up of micron-sized particles, probably produced by soil weathering [11], and are composed by nanophase ferric oxide particles [10].
Different dust phenomena happen on Mars, including dust devils (localized), local dust storms (regional) and global dust storms (global-scale) [3]. In the solar spectral range, where solar light reflection prevails the thermal emission, a dust storm usually appears bright and can mask the underlying low-albedo terrains (e.g. [14]).
The top altitude of local storms varies significantly, ranging from a few hundreds of meters to more than 10-20 km above the surface [7].
In this work, we study a local dust storm observed on Atlantis Chaos region during Martian Year (MY27) by the OMEGA spectrometer [2] on board the Mars Express (MEx) spacecraft. Section 2 describes the analyzed observations. The method of the analysis is presented in Section 3. Finally, our results and conclusions are given in Section 4.

## 2. Observations

We analyze orbit 1441_5 registered by OMEGA in March 2005 (Ls = 168.619°). In the observation the storm is cut at west and is centered at longitude = 176.5° W and latitude = 33.5° S. In the solar part of the spectrum at about 1.2 µm the storm appears as a bright cloud and is characterized by more than twice the signal of surrounding regions. Reflectance factor spectra taken on and off the storm show changes in the spectral shape between around 0.7 and 1.4 µm. This happens since the surface mafic absorption signature is absent on the storm but becomes important by moving from the storm center to its boundaries and to regions outside the storm itself. Hence, an independent knowledge of the spectral albedo of the surface underneath the cloud is required in order to analyze the storm properties with a radiative transfer (RT) model.
In order to retrieve the surface albedo spectra (Section 3), we analyze OMEGA orbit 3262_5, since it is characterized by a low dust optical depth [9] and covers almost the same region where the storm is observed in orbit 1441_5.

## 3. Method and Model

In this study, we consider a part of the intersection between orbits 1441_5 and 3262_5, extending between longitudes 176.5° W and 177.5° W and latitudes 32.0° S and 35.7° S, covering regions both on and off the storm.
To derive the surface albedo spectra of this region we apply the Surface Atmosphere Separation (SAS) method [5] to the pixels of orbit 3262_5.
To retrieve the dust cloud effective radius ($r_{eff}$), top altitude (*ta*) and optical depth at 9.3 µm ($\tau_{9.3}$) we adopt the RT model and inversion algorithm described in [12] and [13].
The atmospheric temperature-pressure profiles and gases mixing ratios are derived from the Mars Climate Database (MCD, [8]).

To account for the dust composition, we adopt the optical constants by [14] and assumed a lognormal particles size distribution with 0.5 effective variance (MCD).

# 4. Results and conclusions.

We obtained spatial maps of the retrieved parameters, showing that larger particles ($r_{eff}$ = 1.6 μm) are gathered at the center of the storm, where $\tau_{9.3} > 7$ and the dust cloud extends to more than 18 km. On the other hand, outside the storm, the dust appears confined down to the surface with smaller particles ($r_{eff} < 0.9$ μm) and $\tau_{9.3} < 0.2$ (in agreement with the estimates from [9]). By analyzing the thermal inertia of the region [4] we deduce that the dust making the storm comes from a region at west/north-west of Atlantis Chaos, characterized by low thermal inertia values. Once lifted, the dust is then confined within the north-east ridge of Atlantis Chaos by the combination of the horizontal and vertical wind profiles (MCD), in agreement with the results from our retrieval.

Finally, by comparing the retrieved dust optical depths with the data in the thermal range, we deduced that when $\tau_{9.3} > 1$, the 5 μm transmission window, usually adopted to sound surface temperatures (e.g. [1]), cannot be reliably used. A paper describing this study has been submitted to Icarus.

# Acknowledgements

This study has been performed within the UPWARDS project and funded in the context of the European Union's Horizon 2020 Programme (H2020-Compet-08-2014), grant agreement UPWARDS-633127. Moreover, the study has been co-funded within the PRIN INAF 2014. We would like to thank the whole OMEGA team for the support in this work.

# References

[1] Bellucci, G., et al., 2007. Evidence for enhanced hydration on the northern flank of Olympus Mons, Mars, Icarus, 192, 2, p. 361-377.

[2] Bibring, J.P., et al., 2004. Omega: Observatoire pour la minéralogie, l'eau, les glaces et l'activité. ESA SP-1240: Mars Express: The Scientific Payload. ESA Publications Division, Estec, Noordwijk, The Netherlands, pp. 37–49.

[3] Briggs, G.A., et al., 1979. Viking Orbiter imaging observations of dust in the martian atmosphere. J. Geophys. Res. 84, 2795–2820.

[4] Christensen, P. R. and H. J. Moore (1992). The Martian surface layer, in Mars, edited by H. H. Kieffer, et al., pp. 686-729, University of Arizona Press, Tucson, AZ.

[5] Geminale, A., et al., 2015. Removal of atmospheric features in near infrared spectra by means of principal component analysis and target transformation on Mars: I. Method. Icarus, Volume 253, p. 51-65.

[6] Kahre, M.A., et al., 2008. Investigations of the variability of dust particle sizes in the martian at-mosphere using the NASA Ames General Circulation Model. Icarus 195, 576-597.

[7] Määttänen, A., et al., 2009. A study of the properties of a local dust storm with Mars Express OMEGA and PFS data. Icarus 201, 504-516.

[8] Millour, E., et al., 2015. The Mars Climate Database (MCD version 5.2). European Planetary Science Congress 2015, held 27 September - 2 October, 2015 in Nantes, France.

[9] Montabone, L., et al., 2015. Eight-year climatology of dust optical depth on Mars. Icarus, Volume 251, p. 65-95, doi: 10.1016/j.icarus.2014.12.034.

[10] Morris, R.V., et al. 2006. Mössbauer mineralogy of rock, soil, and dust at Gusev Crater, Mars: Spirit's journey through weakly altered olivine basalt on the plains and pervasively altered basalt in the Columbia Hills, J. Geophys. Res., 111, E02S13.

[11] Pollack, J., et al., 1979. Properties and effects of dust particles suspended in the Martian atmosphere. J. Geophys. Res., 84, 2929 – 2945.

[12] Oliva, F., et al., 2016. Clouds and hazes vertical structure of a Saturn's giant vortex from Cassini/VIMS-V data analysis. Icarus, Volume 278, p. 215-237.

[13] Sindoni, G., et al., 2013. Development of a Monte-Carlo Radiative Transfer Code for the Juno/JIRAM Limb Measurements. European Planetary Science Congress 2013, held 8-13 September in London, UK.

[14] Wolff, M.J., et al., 2009. Wavelength dependence of dust aerosol single scattering albedo as observed by the Compact Reconnaissance Imaging Spectrometer. Journal of Geophysical Research, Volume 114, Issue E9, CiteID E00D04.