EPSC Abstracts
Vol. 8, EPSC2013-585, 2013
European Planetary Science Congress 2013

The Optical Depth Sensor (ODS) for Mars atmosphere

D. Toledo(1), P. Rannou(1), J.-P. Pommereau(2), A. Sarkissian (2) and T. Foujols (2)
(1) GSMA, Université de Reims, France, (2) LATMOS, Université de Versailles-St-Quentin, GUYANCOURT, France, (daniel.toledo-carrasco@etudiant.univ-reims.fr)

Abstract

A small and sophisticated optical depth sensor (ODS) has been designed to work in the martian atmosphere. The principal goal of ODS is to carry out the opacity due to the Martian dust as well as to characterize the high altitude clouds at twilight, crucial parameters in understanding of Martian meteorology. The instrument was initially designed for the failed MARS96 Russian mission, and also was included in the payload of several other missions [1]. Until recently, it was selected (NASA/ESA AO) in the payload of the atmospheric package DREAMS onboard the MARS 2016 mission. But following a decision of the CNES, it is no more included in the payload.

In order to study the performance of ODS under a wide range of conditions as well as its capable to provide daily measurements of both dust optical thickness and high altitude clouds, the instrument has participated in different terrestrial campaigns. A good performance of ODS prototype (**Figure 1**) on cirrus clouds detection and in dust opacity estimation was previously archived in Africa during 2004-2005 and in Brasil from 2012 to nowadays. Moreover, a campaign in the arctic is expected before 2016 where fifteen ODSs will be part of an integrated observing system over the Arctic Ocean, allowing test the ODS performance in extreme conditions.

In this presentation we present main principle of the retrieval, the instrumental concept, the result of the tests performed and the principal objectives of ODS in Mars.

1. Motivations and objectives

On Mars, dust and clouds are primary elements for studying the interactions of solar radiation with the atmosphere and surface and their influence on the radiation balance. In the absence of massive condensed water and precipitation, dust lifted by storms are the unique condensation nuclei available at the Mars atmosphere. This fact highlights the importance of dust in the vertical structure of the Mars lower atmosphere.

Therefore a capability of modelling the dust and clouds is vital for understanding of meteorology and climate on Mars. The capacity of ODS is the monitoring of dust optical thickness and size distribution on a daily basis as well as the detection of the altitude and opacity of high altitude sub-visible cirrus at twilight.

For validation purpose, ODS prototypes was deployed in West Africa sahel region in Ouagadougou, Burkina Faso next to a AERONET station and now ODS is in Bauru in Brasil. Analyses of the signal returned by ODS are part of the preparation of the instrument for spatial missions.

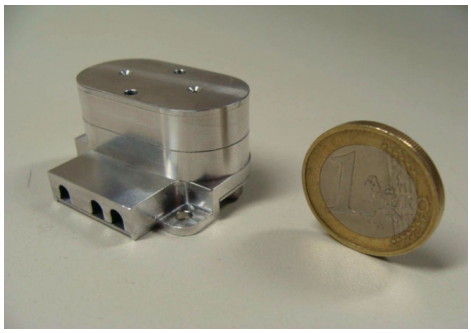

Figure 1: *Optical head of the ODS instrument. The total weight of the instrument for two channels is 63 g : 28 g for the optical head and 35 g for the electronics.*

2. Principle of the measurement

ODS is always oriented to zenith, with an annular field of view between ±25 and ±50 solar zenith angle. The scattered flux is observed from sunrise to sunset and the total flux, given by the direct + scattered flux, only when the sun passes in

the ODS field of view. The method used to retrieve the dust opacity is based on the change observed between the flux scattered by the atmosphere and the total flux observed from the surface. The shape of this sharp step in the flux depends on the total dust opacity. The principal idea of the retrieval procedure is to search a radiative transfer model capable to reproduce this characteristic shape in the ODS signal. A principal characteristic of ODS is that its retrievals are indeed independent of any absolute calibration. This fact is essential for ensure its performance in Mars.

For the cloud detection, the index colour (CI) is used, defined as the ratio between the scattered light at red and blue wavelengths. If a cloud is present during twilight, then a peak must be observed in the time variation of CI [2,3]. As for the dust, clouds properties are retrieved by simulating the ODS signal by a radiative transfer model, but in this case during twilight.

In this work, we will present the procedures used to retrieve the dust optical dust and the high altitude cirrus altitude and opacity. Such procedures were used to analyse the data taken during the terrestrial field campaign mentioned above. We then show our results concerning cloud properties and the dust optical depth. The latter is shown along with the retrieval of the AERONET photometer.

We will also show the type of observation that are possible to obtain in martian environment, concerning the dust and cloud layers.

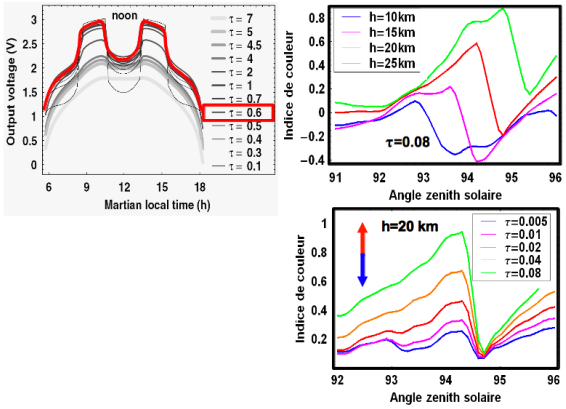

Figure 2: *Left : example of output voltage modelled for one martian day, for several dust optical thickness. The red curve shows how the shape of a measured signal can be fitted with this database and can give the value of τd.) Right: variation of the color index (difference of voltages Ured-Ublue) as a function of time for several values of cloud altitude (zc = h) and with a constant value of τc=0.08 (top figure) and for several values of τc (top figure) with a constant value of zc = h = 20 km (bottom figure).*

References

[1] Maria et al., "Technical aspects of the optical depth sensor", Adv. Space Res., 38, 726-729, (2006)

[2] Tran et al., "Scientific aspects of the optical depth sensor", Adv. Space Res., 36, 2182-2186, (2005)

[3] Tran The-Trung, "Optical Depth Sensor for the measurement of dust and clouds in the atmosphere of Mars. Radiative transfer simulations and validation on Earth", Rapport de thése, Université de Versailles-St-Quentin, (2005)

http://ods.projet.latmos.ipsl.fr/Sciences/These.pdf