EPSC Abstracts
Vol. 6, EPSC-DPS2011-1746, 2011
EPSC-DPS Joint Meeting 2011

The Mars Atmospheric Trace Molecule Occultation Spectrometer (MATMOS) on the 2016 EMTGO mission

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Abstract

We describe the Mars Atmospheric Trace Molecule Occultation Spectrometer (MATMOS) investigation, selected for the 2016 Mars Trace Gas Orbiter (TGO).

1. Introduction

The MATMOS instrument is a Solar occultation Fourier Transform InfraRed spectrometer (SFTIR) with a co-aligned solar imager. The SFTIR will detect, profile, and map with parts per trillion sensitivity a large suite of trace gases, and the solar imager will provide concurrent and collocated measurements of dust and cloud extinction. The investigation, a partnership between the California Institute of Technology (Caltech), the Canadian Space Agency (CSA), and NASA's Jet Propulsion Laboratory (JPL), directly addresses key goals of the 2016 ExoMars Trace Gas Orbiter mission (1) detecting trace gases and (2) characterizing their 3-D distribution in the context of the atmospheric state.

2. Science

2.1 Diagnostic trace gases

The MATMOS investigation will search for trace atmospheric chemical molecules diagnostic of geological and biogenic activity, quantify the lifetimes of those diagnostic gases and establish the role of heterogenous chemistry in the Martian atmosphere. Methane, tentatively detected in 2003 [1-3] lies within MATMOS broad spectral range, as one of many candidate diagnostic gases (see Figure 1). The comprehensive approach to atmospheric chemistry planned in the MATMOS investigation will provide definitive detection of any disequilibrium gases originating from the Mars surface, including methane, and will have the capability to address the mystery of its short chemical lifetime [4,5]. Analysis of suites of trace molecules is believed to be the most promising method to determine the origin of such gases.

2.2 Additional science objectives

MATMOS simultaneous profile measurements of water, CO_2, their isotopologues and cloud will also provide unique insights into atmospheric cycles of CO_2, dust and water, and exchange with surface reservoirs. Vertical profiles of temperature to altitudes greater than 150km, combined with lower atmosphere D/H ratio, will increase understanding of lower and upper atmosphere coupling, complementing the MAVEN investigation into atmospheric escape.

3. Instrument and operations

MATMOS will be situated on the "Sun Deck" of the TGO spacecraft. As the orbiter enters and exits the shadow of Mars, four color visible images and FTIR spectra will be acquired as the sun sets (or rises) by approximately 3 km tangent altitude (see Figure 1). The spectra will be obtained from 850 – 4300 cm^{-1} with S/N greater than 200 and with a spectral resolution of 0.02 cm^{-1}. For the expected inclination of the TGO orbit, spectra will be obtained at both high latitudes and in the tropics in each season. The images and spectra from MATMOS will be processed at the California Institute of Technology by the science team. The spectra and retrieved products will be made available to the public rapidly from the MATMOS web site at Caltech and its mirror at the Canadian Space Agency. The high S/N and high spectral resolution allow precise and accurate measurements of a large suite of compounds. Averaging of the data obtained below 20 km reduce the limit of detection by approximately 3. Thus, it is expected that MATMOS will be able to quantify the abundance of methane, for example, down to concentrations as low as 3 ppt.

4. Acknowledgements

The MATMOS Investigation is funded by NASA and CSA. Instrument heritage comes from the ACE-FTS instrument built by ABB Bomem, Quebec, Canada; and JPL's Mark IV and ATMOS instruments.

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Figure 1: The MATMOS science investigation