

# Atmospheric modelling for NOMAD-UVIS on board the ExoMars Trace Gas Orbiter mission

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## Abstract

The Ultraviolet and Visible Spectrometer (UVIS) instrument development process requires the construction of an atmospheric model to provide synthetic UV transmission spectra. We discuss the requirements of the model to enable observational limits to be found, and the potential for certain atmospheric parameters to be further constrained.

## 1. Introduction

The Nadir and Occultation for Mars Discovery (NOMAD) instrument is currently being developed for the ExoMars Trace Gas Orbiter mission. In preparation a radiative transfer model is being constructed to provide synthetic spectra, to simulate the observations of the UV channel.

Using spectroscopy to study atmospheric constituents has been a widely used technique for many decades. It is by using this method we learn the composition of non-terrestrial atmospheres. Spectrometers can either be Earth bound, or sent on spacecraft for remote observations. Observatories on Earth, such as the NASA Infrared Telescope Facility in Hawaii provide long term observations to compliment the remotely recovered data [1]. Other bodies can be observed from a lander on the surface, or from an orbital position. Mars has been observed in this way since the days of Mariner, and most recently with the SPICAM instrument on board Mars Express [2].

## 2. Rationale

We currently have a limited understanding of many features of the atmosphere of Mars, specifically dust and aerosols. The parameters describing the size distribution, vertical distribution and composition of dust require further investigation, although estimations have been made [3, 4]. Based on certain assumptions we have potential values for the dust optical properties of single scattering albedo and the asymmetry fac-

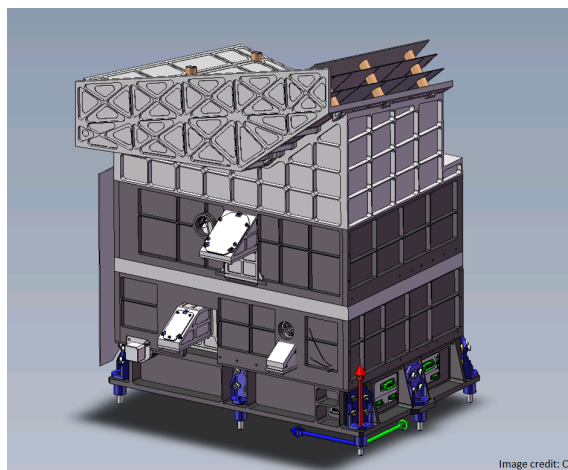


Figure 1: Overview of NOMAD, the UVIS channel is the lower right hole and periscope.

tor [5], although more time has been spent investigating these for visible and IR wavelengths as opposed to UV. Better estimates of these parameters leads to better characterization of dust for global climate modelling and to a better understanding of dust composition, shape and population and so its role in the martian climate system. This would benefit future missions, for example through improved accuracy of aerobreaking calculations.

Another atmospheric constituent active at shorter wavelengths is ozone. We have some idea of when and where ozone is found, but predictions do not always match observations [6, 7]. Further sensitive measurements will continue to aid our understanding of how ozone behaves on Mars, expanding the spatial and temporal data set to increase our understanding of the system as a whole.

## 3. The UVIS instrument

The ExoMars TGO is planned for a 2016 launch. On board will be UVIS, an ultra violet and visible light

spectrometer forming part of the NOMAD instrument. UVIS will take frequent, high resolution (1 nm) spectra in both nadir and occultation viewing orientations over the wavelength range of 200 - 650 nm. These highly resolved spectra will improve analysis of many atmospheric features, for example the Hartley band of ozone absorption which requires accurate measurement. As a significant absorber of UV, determining the spatiotemporal distribution of ozone will assist in quantifying the amount of UV radiation reaching the surface. This needs to be known due to the damaging effect short wavelength radiation could have on potential life [8]. The instrument will also be able to detect the presence of clouds.

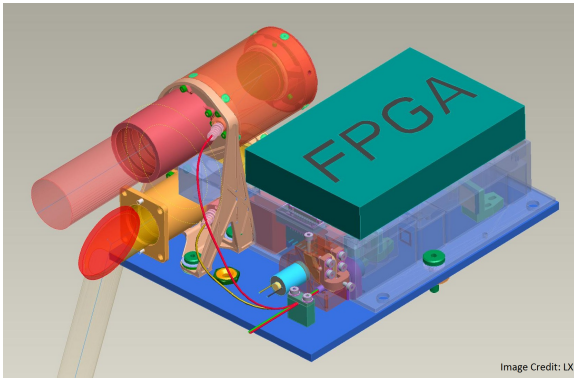


Figure 2: Overview of the UVIS instrument, showing the two measurement modes of solar occultation and nadir.

## 4. The model

A forward model will be used to solve this inverse problem of atmospheric retrievals. Existing core radiative transfer code will be modified to simulate various dust loading scenarios, cloud formations and viewing geometries as accurately as possible. The latest experimental results will be used where appropriate, for example molecular absorption cross sections will be needed for all relevant gases.

The model will also provide details of detection limits for a given set of climatic conditions, for example the lowest operational altitude achievable during occultation measurements. In addition the model will allow constraints to be placed on certain parameters or distributions, such as the vertical distribution of dust.

The aim of this work is to both assist the instrument team and to constrain parameters through spectral analysis of different atmospheric scenarios in or-

der to maximise the scientific outputs from the instrument data.

## Acknowledgements

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