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Radiative transfer modelling for the NOMAD-UVIS instrument on the ExoMars Trace Gas Orbiter mission

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Abstract

The NOMAD (Nadir and Occultation for MArs Discovery) instrument is a 3-channel (2 IR, 1 UV/Vis) spectrometer due to fly on the 2016 ExoMars Trace Gas Orbiter mission. A radiative transfer model for Mars has been developed providing synthetic spectra to simulate observations of the UVIS channel in both solar occultation and nadir viewing geometries. This will allow for the characterization and mitigation of the influence of dust on retrievals of ozone abundance.

1. The UVIS instrument

UVIS is an ultraviolet and visible spectrometer forming part of the NOMAD instrument. UVIS will take frequent, high resolution (1 nm) spectra over the wavelength range of 200 - 650 nm (the model is currently running for 100 - 1100 nm). As a significant absorber of UV, determining the spatio-temporal distribution of ozone will assist in quantifying the amount of UV radiation reaching the surface, relevant for astrobiological studies of the surface environment. The instrument will also be used to investigate cloud properties, potentially differentiating between those composed of H$_2$O and CO$_2$ ice.

2. Rationale

Spectroscopy has been used to study atmospheric constituents for many decades. It is through this method that we learn the composition of non-terrestrial atmospheres. Numerous features of the atmosphere of Mars are not completely understood, particularly aerosols such as dust and ice cloud particles. The parameters describing the spatial, temporal, and size distribution of dust along with its composition require further investigation, although estimates have been made [1, 2]. Constraints on the values for the dust optical properties of single scattering albedo and the asymmetry factor have been previously derived [3], although most investigations have addressed these parameters in the visible and IR wavelength ranges 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, and would allow for improved studies of the thermal role of airborne dust.

Another atmospheric constituent active at shorter wavelengths is ozone. It is known to some extent when and where ozone is found, but predictions do
4. Summary

Work is ongoing to maximize the scientific output of the future mission data with particular emphasis on the detection of trace gases including \( \text{O}_3 \) and potentially \( \text{SO}_2 \). Assessing the impact of variations in the properties and distribution of airborne dust on retrievals forms a major part of this study.

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References


