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# First radiometric calibration of the NOMAD/UVIS nadir data

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## Abstract

The NOMAD ("Nadir and Occultation for MArs Discovery") spectrometer suite on board the ExoMars Trace Gas Orbiter (TGO) has been designed to investigate the composition of Mars' atmosphere using a suite of three spectrometers operating in the UV-visible and infrared. In this work, we will show and compare the results of the different calibration methods, including straylight removal and radiance conversion, used to produce the UVIS level 1 data (calibrated). Comparisons with MRO/MARCI will also be presented.

## Introduction

NOMAD is a spectrometer operating in ultraviolet (UV), visible and infrared (IR) wavelengths covering large parts of the 0.2-4.3 µm spectral range [1].

The UV-visible "UVIS" instrument covers the spectral range from 200 to 650 nm and can perform solar occultation, nadir and limb observations [2]. The main purpose of UVIS is dedicated to the analysis and monitoring of ozone and aerosols such as dust and ice clouds.

In order to perform these analyses, the data require an accurate calibration. Indeed, the presence of straylight coming from inside the UVIS range but also from the outside in the near infrared, contaminates the data and has to be correctly removed before the radiance conversion. The straylight removal is critical in the calibration as it strongly affects the UV range, where the signal is the lowest, which is the key for ozone and aerosol analysis [3].

## Results and comparisons

Different methods of stay-light removal have been developed in parallel: 1) an experimental method for straylight removal, based on lab measurements on the flight model and completed on the spare model after launch. The radiance conversion is obtained from lab measurements using known lamp sources on the flight model; 2) Two in-flight methods using the non-illuminated part of the CCD to derive the straylight. The radiance conversion is then obtained using as known source a solar measurement from a solar occultation.

These methods are therefore completely independent. Their results were analyzed and compared and were helpful to better understand the straylight behavior and improve its removal.

In the present work, we will show and compare the calibrated spectra obtained with the different calibration methods. We will also provide comparisons with concurrent MRO/MARCI measurements [4], recorded in very similar observation geometry, in order to assess and validate these calibration results.

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## References

[1] Vandaele et al. 2018. Space Sci. Rev.
[2] Vandaele et al. 2015. Optics Express.
[3] Willame et al. 2017. Planet. Space Sci.
[4] Wolff et al. 2010. Icarus.