EGU24-16442, updated on 16 Feb 2025
https://doi.org/10.5194/egusphere-egu24-16442
EGU General Assembly 2024

Sensitivity studies for the VeSUV/VenSpec-U instrument onboard ESA's EnVision mission

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The next ESA mission to Venus, EnVision, aims to study the planet as a whole, including its various constituting parts as well as their interactions and coupling processes. Several instruments will therefore compose the payload: a synthetic aperture radar (VenSAR, NASA), a subsurface radar sounder and a suite of three spectrometers (VenSpec) will be embedded, and a radioscience experiment will be implemented. Among them, the UV channel of the spectrometer suite, VenSpec-U, will observe the atmosphere above the clouds and will focus on the characterisation of the sulphured gases SO_2 and SO, the monitoring of the unknown UV absorber and dynamical processes. These four topics have been identified as the main science objectives of the instrument and have driven the elaboration of a preliminary design based on the requirements (e.g. spectral range, spectral and spatial resolution) that were formulated with respect to these goals.

The compliance of the current design with respect to these requirements, regarding in particular the precision of the retrieved science data, can then be assessed. Sensitivity studies are therefore performed using the Radiative Transfer Model (RTM), updated from the one used for SPICAV-UV/Venus Express retrievals (Marcq et al., 2020), that allows to link atmospheric features and UV reflectance spectra. Two types of perturbations are considered : errors of random nature arising from the presence of noise on the signal, or systematic errors caused by various effects that induce biases on the measurements. The first ones can be characterised through the influence of the Signal-to-Noise Ratio (SNR) on the uncertainties associated to each retrieved parameter through the fitting algorithm. Limits in terms of SNR can then be defined in order to ensure the compliance with the specifications. The second ones are referring to the impact of biases on the retrievals' accuracy, and evaluate more specifically the effects of the similarities between the spectral characteristics of these biases and those of the atmospheric components aiming to be detected. The implemented method is based on the Effective Spectral Radiometric Accuracy (ESRA) requirement, previously defined within the framework of the ESA Sentinel missions. It allows to study biases independently as well as potential compensations, so that allowable envelopes of residual errors can then be estimated for each of the considered biases.