ALTIUS Ozone Retrieval Algorithm in Solar Occultation Mode Validated using SAGE III Observations

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About the instrument

The **Atmospheric Limb Tracker for the Investigation of the Upcoming Stratosphere (ALTIUS)** is the **European Space Agency's (ESA)** future ozone mission, part of **ESA's Earth Watch Programme**.

ALTIUS is designed to perform measurements in various geometries to optimize global coverage. This includes observing limb-scattered solar light during the day, solar occultations at the terminator, and stellar, lunar, and planetary occultations during the night. The primary mission objective is to obtain high-resolution stratospheric ozone concentration profiles. Given its diverse measurement geometries, ALTIUS is considered a necessary successor to **ESA's SCIAMACHY** and **GOMOS** instruments, which were retired after the decommissioning of ENVISAT in 2012.

The ALTIUS payload, mounted on a PROBA platform, comprises three independent imagers: **UV (250-355 nm), VIS (440-675 nm),** and **NIR (600-1040 nm)** channels. Each imager can independently capture images at desired wavelengths and acquisition times, allowing for optimal wavelength and acquisition time selection. This feature enhances vertical resolution, enabling the retrieval of vertical profiles of various chemical species, including but not limited to O3, NO2, and aerosols.

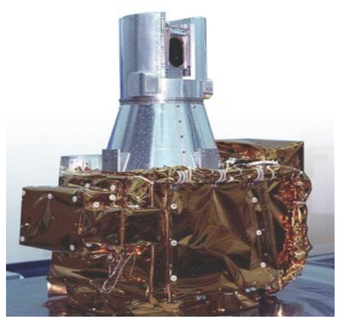
The mission is set to launch in **2026** from Kourou, aboard the **Vega-C launcher**.

ALTIUS
credit: ESA

Introduction

The focus of this work is on simulating the ozone retrieval algorithm in the **Solar Occultation configuration (SoO)** , using data from the **Stratospheric Aerosol and Gas Experiment (SAGE-III)** on board of **the ISS**. Since 2017, SAGE-III on ISS has been producing Solar Occultation measurements in the UV/VIS spectrum, providing spectral coverage in selected wavelengths from 280nm to 1040nm.

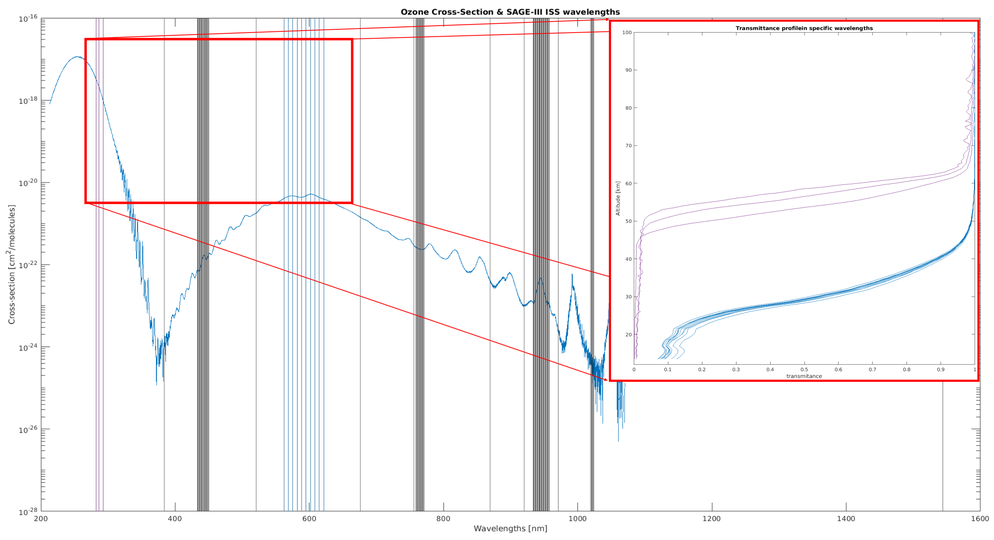
Due to SAGE-III's similar measuring geometry, its large dataset, and high spectral resolution, it forms a good data source to simulate ALTIUS data with. The objective of this work is therefore to adapt SAGE-III data to align with ALTIUS's SoO configuration. This will help us validate the L2 algorithm and verify the Ozone product performance by comparing the results with the SAGE-III dataset.



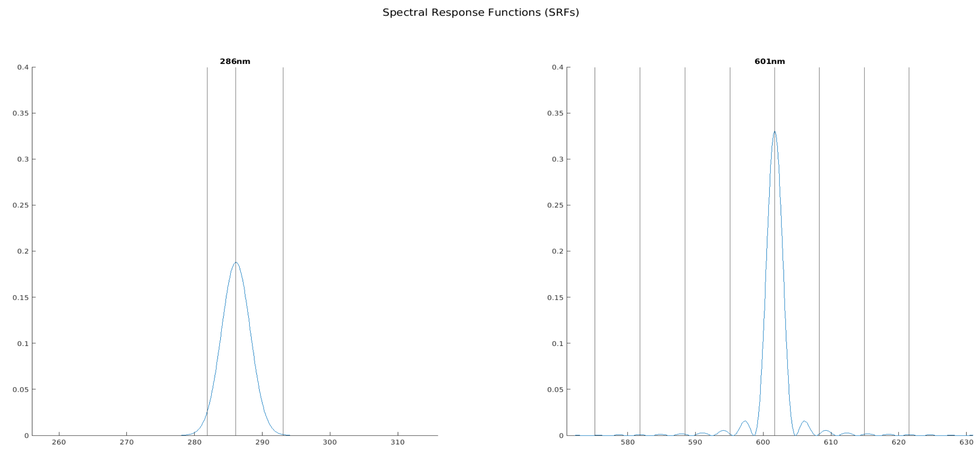
SAGE III
credit: NASA

Restrictions

1. While SAGE-III instrumental spectral resolution is high, in practice the L1 products of SAGE-III do not have high spectral resolution.
2. The imagers of ALTIUS are not sensitive to single values of wavelengths. While the highest sensitivity will be at that given wavelength, the measurements will be affected by other wavelengths, characterized by **Spectral Response Functions (SRFs)** that depend on the wavelength measured.

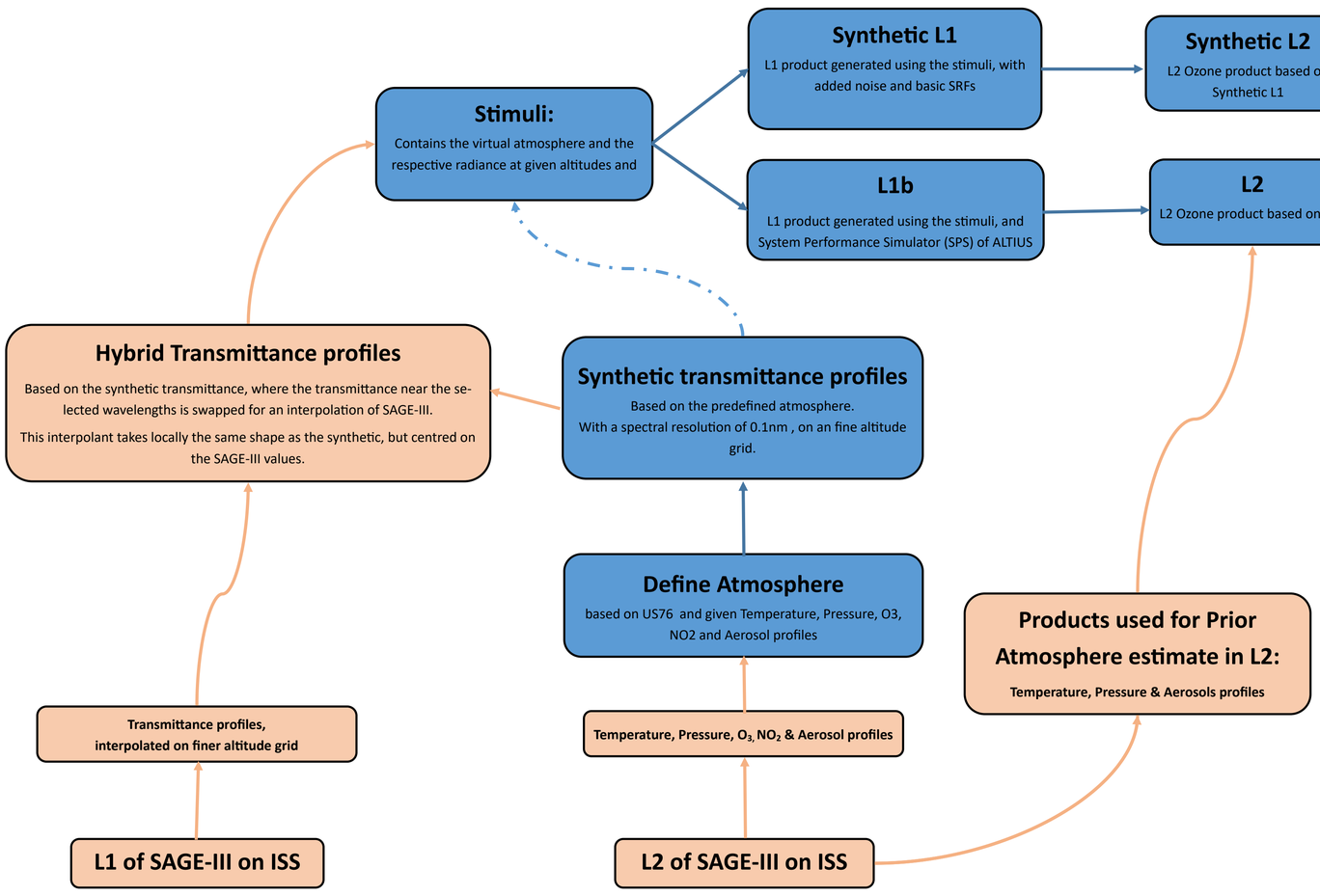


The SAGE-III wavelengths leave a 10km gap of sensitivity to O_3

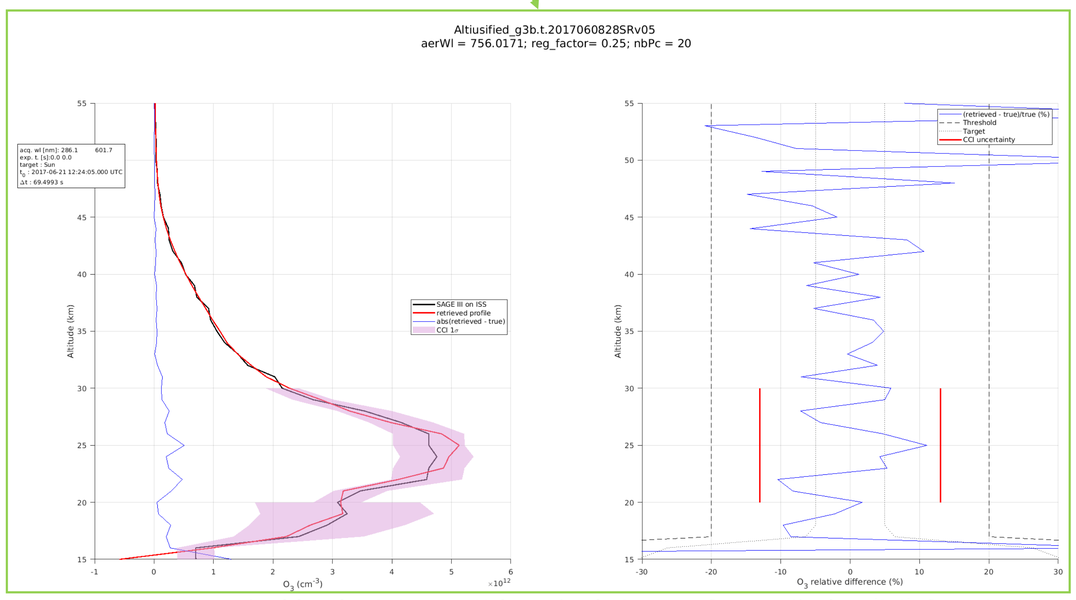


SRFs of ALTIUS centred around specific SAGE-III wavelengths

End-to-End Process



Result



Ozone retrieval, based on SAGE-III on ISS data, using the System performance Simulator (SPS) of ALTIUS.

Uncertainty bars are based on the Range Comparison Spread of the Ozone CCI:
https://climate.esa.int/media/documents/Ozone_cci_PVIR_4.0_3.pdf