Evolution of Aeolus Atmospheric and Solar Background Signals

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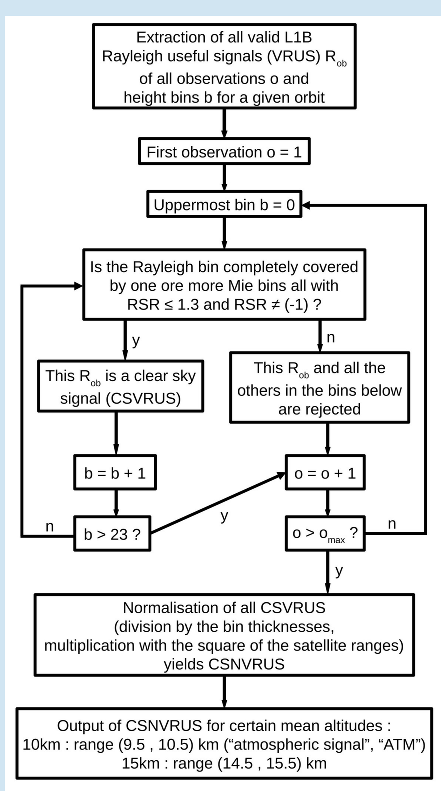
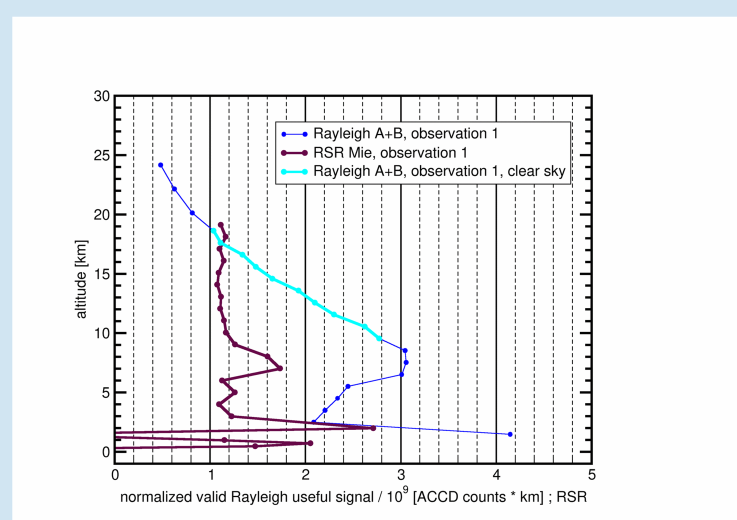
Motivation

The laser signals backscattered by air molecules are one of the system parameters which are regularly monitored to assess the ALADIN instrument performance on board the Aeolus satellite. To avoid interfering signals coming from cloud particles and aerosols, the latter have to be suppressed. In this way, only clear sky conditions, and correspondingly clear sky normalised valid Rayleigh useful signals (CSNVRUS), are taken into account.

Determination of L1B Rayleigh Useful Signals for Clear Sky Conditions to Eliminate Cloud & Aerosol Effects



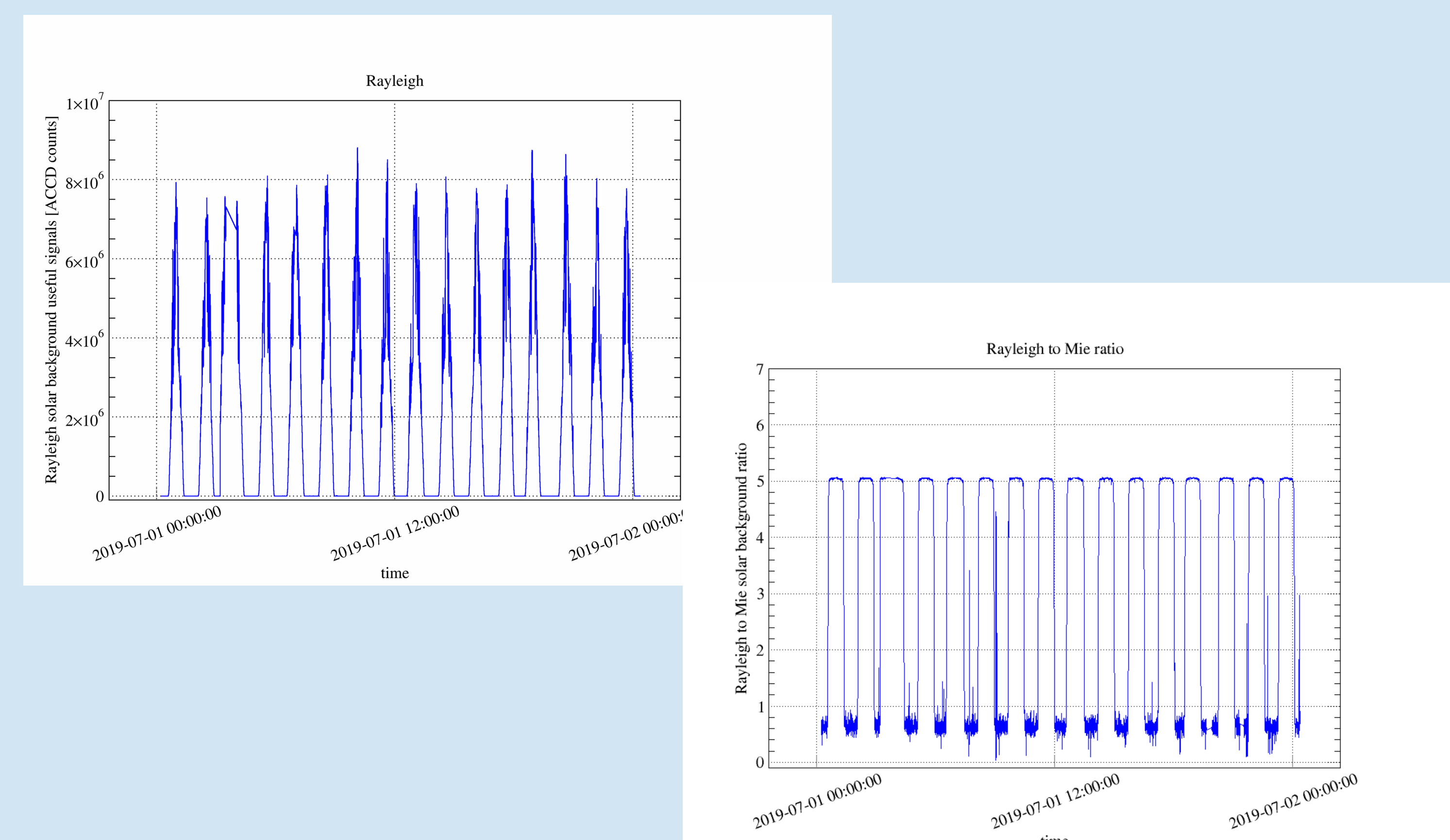


Example of CSNVRUS determination :
- 01.07.2019, orbit 4952, observation 1
- Blue line: L1B NVRUS
- Maroon line : Refined scattering ratio (RSR) Mie
- Cyan line : resulting L1B CSNVRUS
- Probably clouds at altitudes of about 7km – 8km, RSR up to about 1.8
- Clouds and/or PBL aerosols at altitudes of about 0.7km – 2km, RSR up to about 2.7

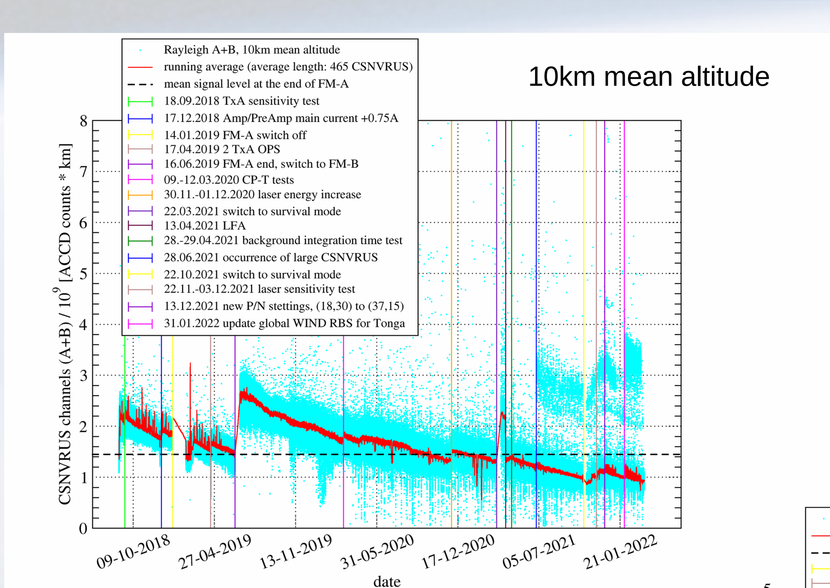
L1B Mie and Rayleigh Useful Signals for Solar Background

The evolution of the solar background (SBG) signals is also regularly monitored because they are applied to correct the atmospheric Rayleigh and Mie signals. Furthermore they have a noticeable influence on the Rayleigh channel wind errors.

Daily cycle : The Mie and Rayleigh SBG signals show a periodic behaviour along the orbits. This is caused by the changing sun illumination seen by Aeolus. Their ratio shows also a periodic behaviour.

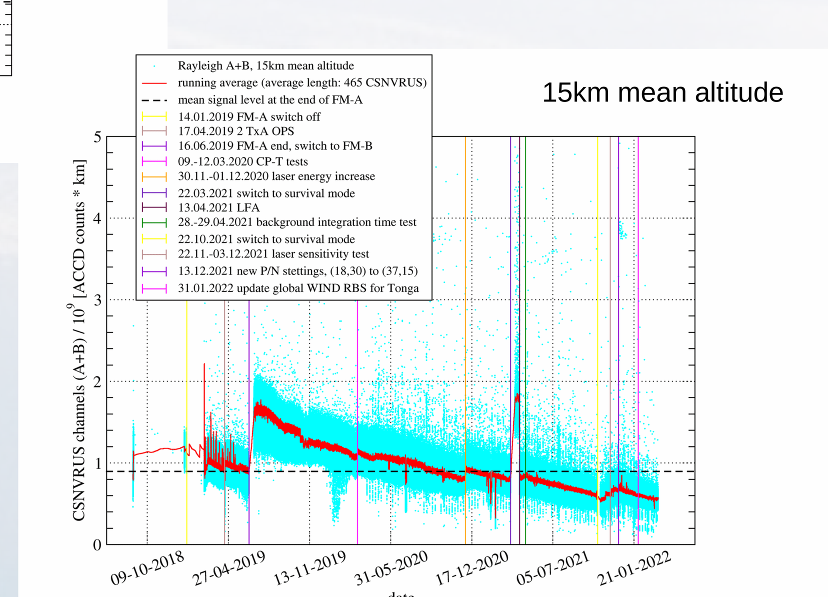


Evolution of L1B Rayleigh Useful Signals for Clear Sky Conditions at 10km and 15km Mean Altitude during FM-A and FM-B

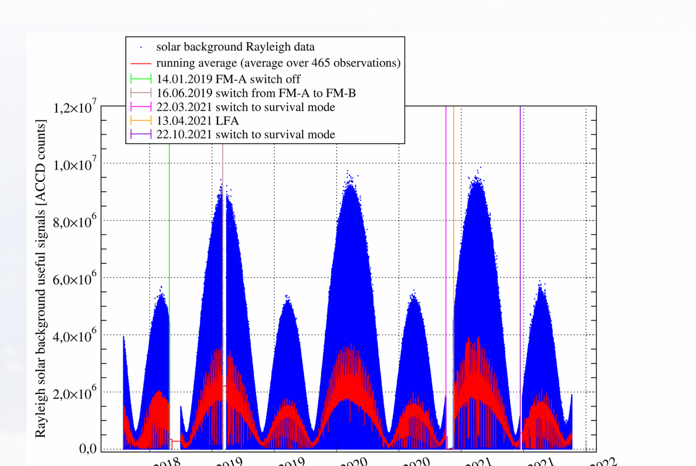


A general trend of decreasing atmospheric signal level is observed during the mission lifetime. For instance, a mean decrease rate of 1.3% per week at both altitudes in 03.05.-11.10.2021 has been seen. This period shows a relatively constant signal loss.

There have been several measures to achieve a larger atmospheric signal gain. The largest signal increase has been obtained after the switch from FM-A to FM-B in June 2019, so far (10km : 77.0%, 15km : 78.0%). The signal level in mid-March 2022 is at about 35% (10km) and 34% (15km), respectively, of the FM-B maximum signal level in July 2019.

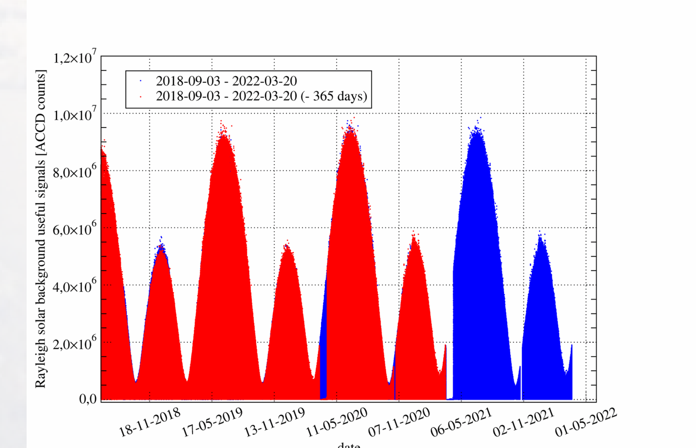


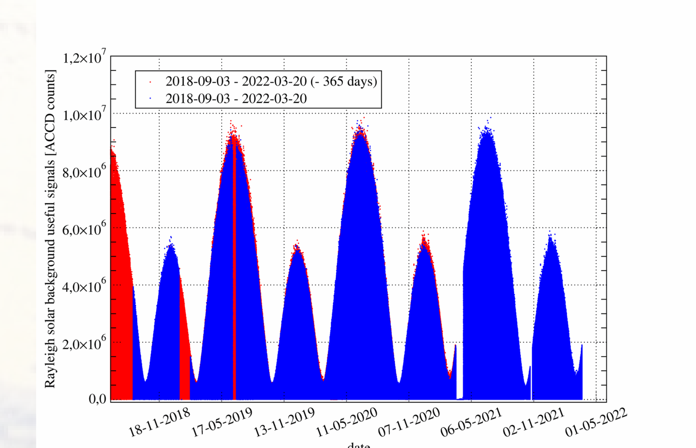
Evolution of L1B Rayleigh Useful Signals for Solar Background during FM-A and FM-B



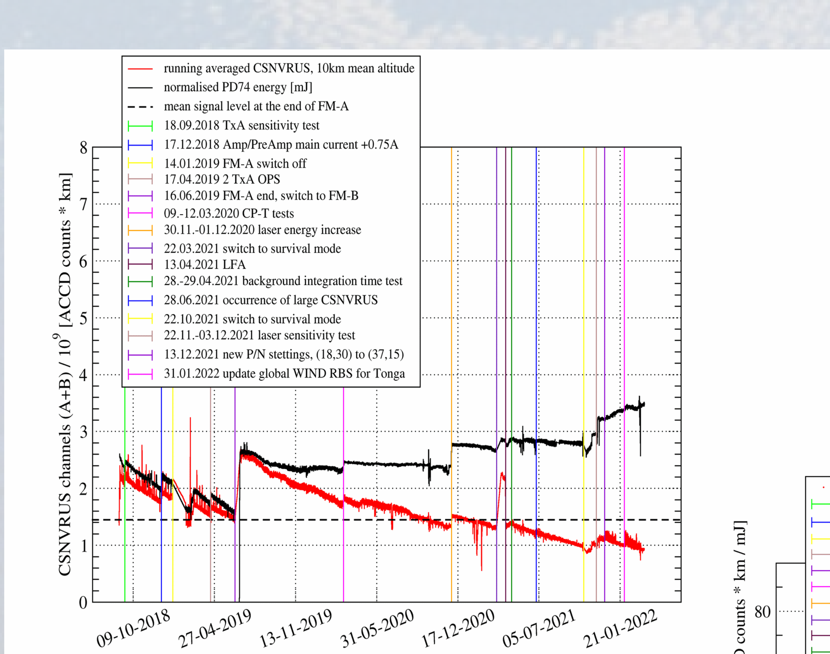
Yearly cycle : The maxima of the Mie and Rayleigh SBG signals show also an oscillating behaviour in time with a primary maximum in June and a secondary maximum in December, and minima in March and October of every year. This is caused by the Earth's orbit around the sun.

The year-to-year differences of the Mie and Rayleigh SBG signals are small indicating no degradation of the optical elements in the receive path and also no additional straylight. This is important to understand the observed atmospheric signal loss.



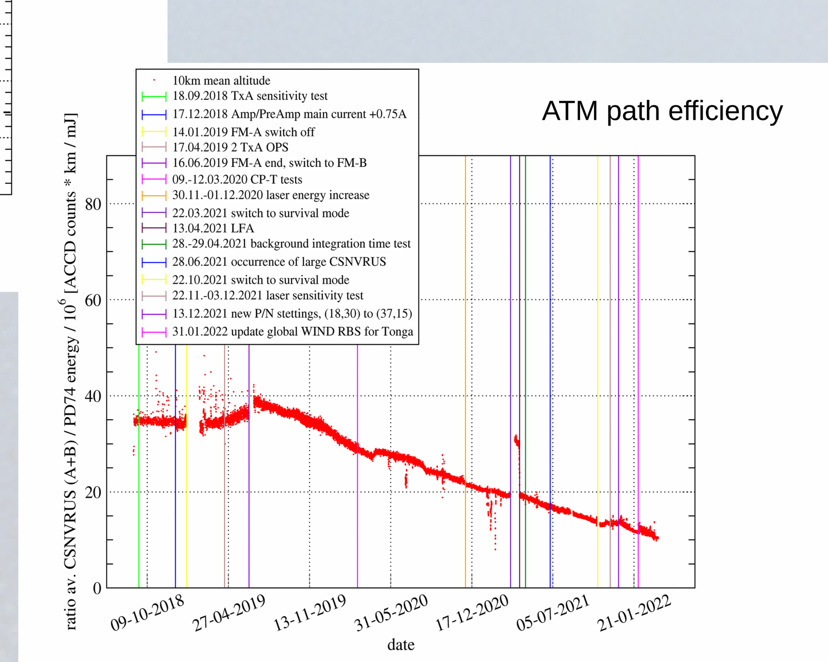


Evolution of L1B Rayleigh Useful Signals for Clear Sky Conditions at 10km Mean Altitude and UV Laser Energy during FM-A and FM-B

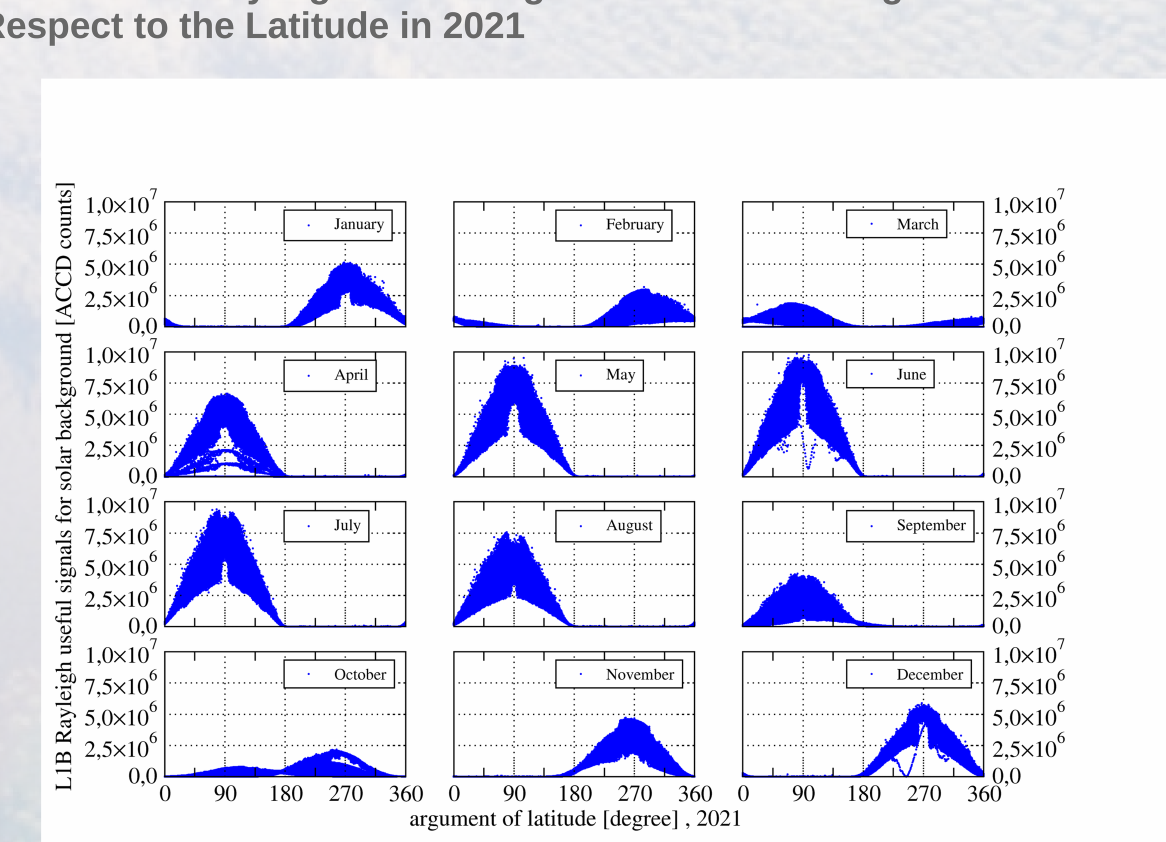


During FM-A, the atmospheric Rayleigh signals followed mainly the emitted laser energy. Their ratio (ATM path efficiency) is, in particular, nearly constant in the beginning of FM-A. Thus the atmospheric signal loss was a consequence of the decreasing laser energy.

Only in the beginning of FM-B, the laser energy decreased over a longer period. The atmospheric Rayleigh signals decreased too, but with a larger rate. Several measures to increase the laser energy output have succeeded. In contrast to this, the general trend of decreasing atmospheric signals has continued. Investigations to improve this situation are ongoing.



Evolution of L1B Rayleigh Useful Signals for Solar Background with Respect to the Latitude in 2021



Yearly cycle : The Mie and Rayleigh SBG signals are maximal in the North Pole region during the primary maximum in June. They are maximal in the south Pole region during the secondaty maximum in December. During the yearly minima in March and October, the measured SBG maximum passes the equator.
(argument of latitude : 0° - equator, 90° - North Pole, 180° - equator, 270° - South Pole, 360° - equator)

The maximum of the annular solar eclipse in the Arctic on 10.06.2021 and the maximum of the total solar eclipse in Antarctica on 04.12.2021 are seen as low SBG signals.

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