Study of TROPOMI/ALH (Aerosol Layer Height) Product Over Europe Using EARLINET Data Base and NATALI Software

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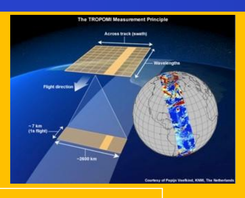
Motivation

Develop a NRT(Near Real Time) procedure for comparison between Aerosol layer heights derived from satellite passive remote sensing measurements(S5P/TROPOMI) and from ground based active remote sensing measurements

Data used

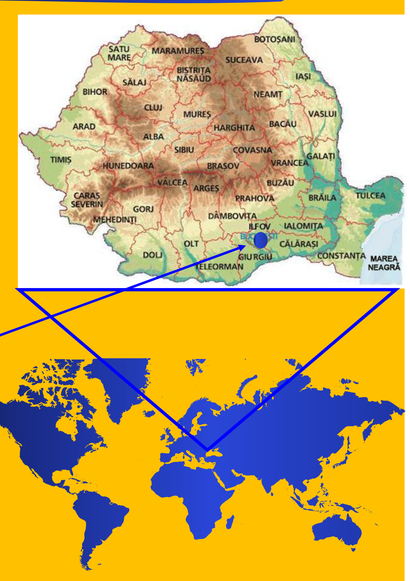
Satellite S5P/TROPOMI level 2 ATBD – ALH



The technique for retrieving aerosol layer height is based on optimal estimation (Rodgers, 2000), where an RTM that calculates the top of atmosphere oxygen A-band spectra is fitted to TROPOMI measured oxygen A-band spectra.(KNMI)	The retrieved aerosol layer mid height can be interpreted as an average aerosol height weighted by the extinction coefficient at each height	The target requirement on the accuracy and precision of retrieved Aerosol Layer Height is 0.5 km or 50 hPa
The height of such layer (one layer!) is retrieved for daytime cloud-free conditions	The TROPOMI Aerosol Layer Height (**ALH**) product focuses on retrieval of daytime vertically localized aerosol layers such as desert dust, biomass burning aerosol, or volcanic ash plumes, but the aerosol type is not provided in the satellite file.	ATDB recommendation is to ignore data with quality flag qa_value < 0.5

Ground based measurements

The lidar systems can provide information regarding the aerosols content on multiple layers due to their temporal and vertical high resolution.	**The NATALI software** (Neural Network Aerosol Typing Algorithm Based on Lidar Data) allows retrieving the most probable aerosol types within a layer from lidar data, as contained in the EARLINET/ACTRIS* database (Nicolae D. et al, 2018).	The input of the NATALI is represented by the EARLINET lidar files in the NetCDF format, containing backscatter coefficient profiles (1064nm, 532nm and 355nm), extinction coefficient profiles (532nm and 355nm), and optionally linear particle depolarization ratio profile (LPDR) at 532nm
NATALI software is detecting the layer boundaries with the gradient method (Belegante et al, 2014) using the 1064 nm backscatter coefficient profile	The heights of each aerosol layer (with a minimum thickness of 300m) is retrieved for cloud-free conditions	Multiwavelength Raman lidar measurements were performed at the Romanian Atmospheric 3D Observatory – RADO, Magurele, Romania, 6 km South of Bucharest



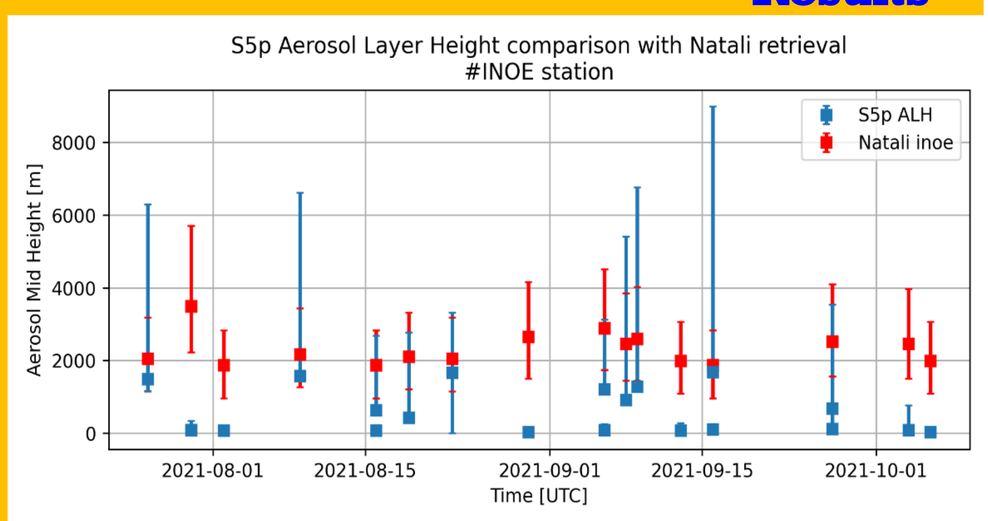
Procedure for ALH data intercomparison ground-satellite

Find in the S5p data base all layers 2018-2021 measured by the satellite in a circle of about 50km) around the ground based location and then average the values

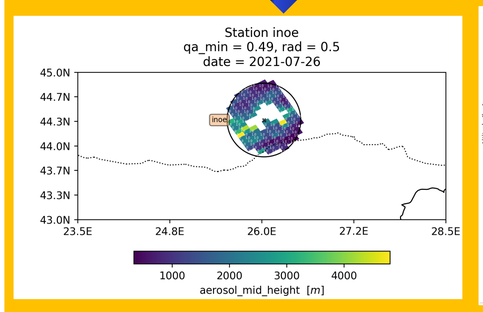
Use the ground based active remote sensing's data base and calculate all layers on an averaged profile (time interval 1 hour around the satellite overpass with an aerosol layer identified)

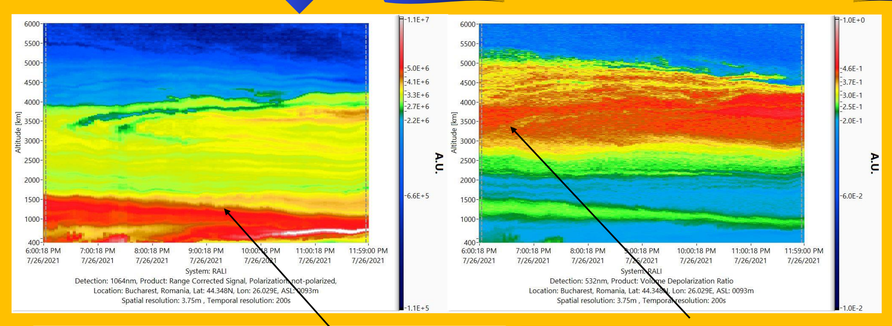
Compare the satellite and ground based ALH values

Results



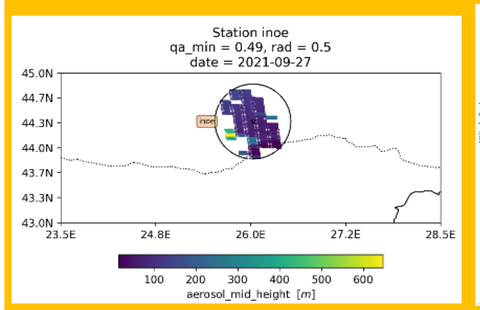
Results-2 case studies

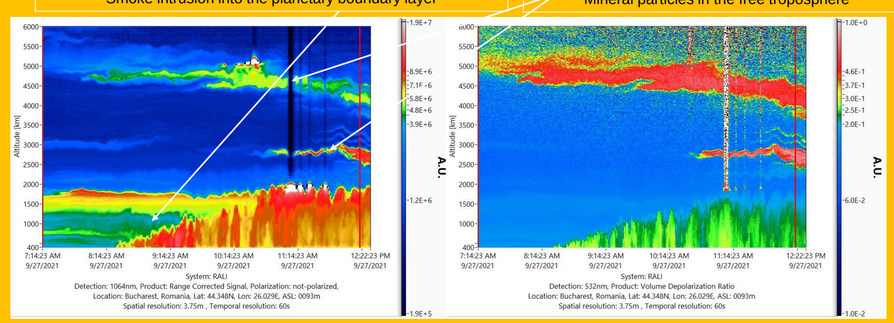




Smoke intrusion into the planetary boundary layer

Mineral particles in the free troposphere





several cases where distinctly separated elevated and boundaryaerosols layer are present in the same scene- satellite product derives one layer

- Satellite product-for one overpass, the available pixels to be averaged in the 50km circle above Magurele vary between 6-109
- July-October 2021-117 cases of layers over Magurele (INOE station) were retrieved from TROPOMI measurements, but 62 cases are below 500m- the new improved algorithm released in June 2021 brings much more cases; (2018-2020 only about 15
- In the upper right figure-20 cases ALH/S5P quality assured-high temporal resolution observation with lidar and aerosol typing with NATALI software (Nicolae et al, 2018) for the identified layers; 10 cases ALH/S5P with altitudes below 100m; 10 cases validated

Future plans

Validation study and implementation of a method for comparison of ALH/S5P using Aerosols layers from the ceilometer network 129 ceilometers 2018-2021 part of e-profile:: https://e-profile.eu/#/cm_profile

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