PROGRAMME OF THE EUROPEAN UNION

co-funded with esa

Case studies of long range transported aerosols over Romania as seen by ground based lidar and TROPOMI

Presentation by Anca Nemuc, INOE

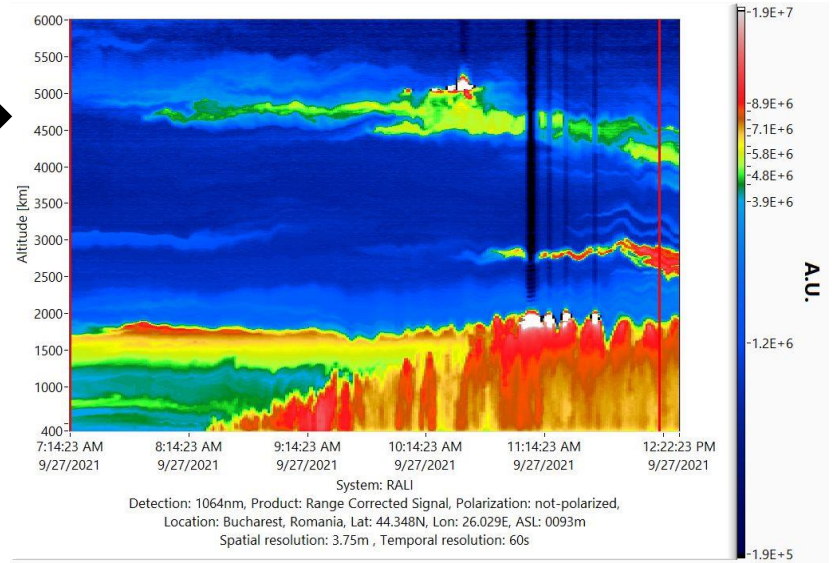
Team: *Alexandru Dandocsi*[2], Doina Nicolae[1], Iwona Stachlewska[3], Jeni Vasilescu[1], Victor Nicolae, Alexandru Ilie[1], Livio Belegante[1], Cristian Radu[1]

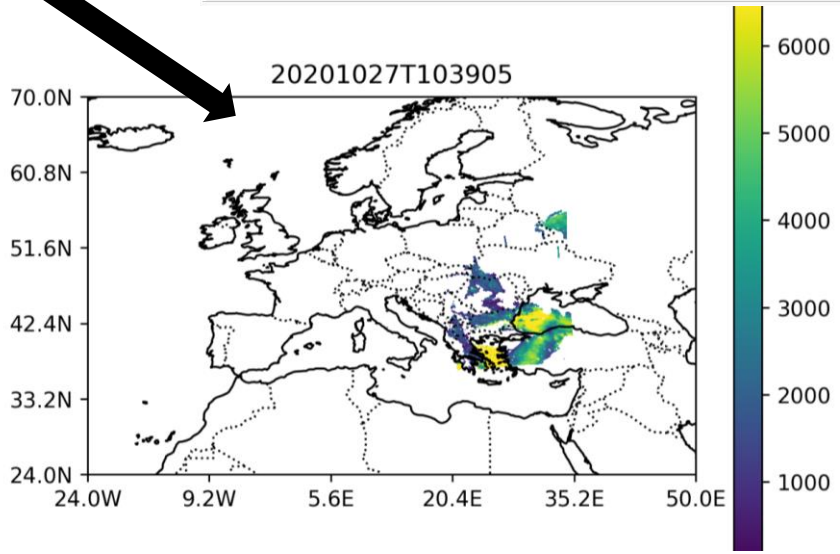
1. National Institute of Research and Development for Optoelectronics, INOE, Romania
2. ESA/ESRIN, Italy
3. University of Warsaw, Faculty of Physics, Poland

Sentinel-5P Mission: 5 years anniversary
10-14 October 2022, Taormina, Italy

Outline

- Aerosol layers from the ground based lidar
- Aerosol layers from TROPOMI
- Behind the scenes - comparison of the two views
- Case study
- Future work





MARS = Magurele centre for Atmosphere and Radiation Studies

- A 20,000 sqm atmospheric observatory
- Located 8 km SW Bucharest capital city of Romania
- instruments related ACTRIS RI, PANDONIA, AERONET

MARS = Magurele centre for Atmosphere and Radiation Studies

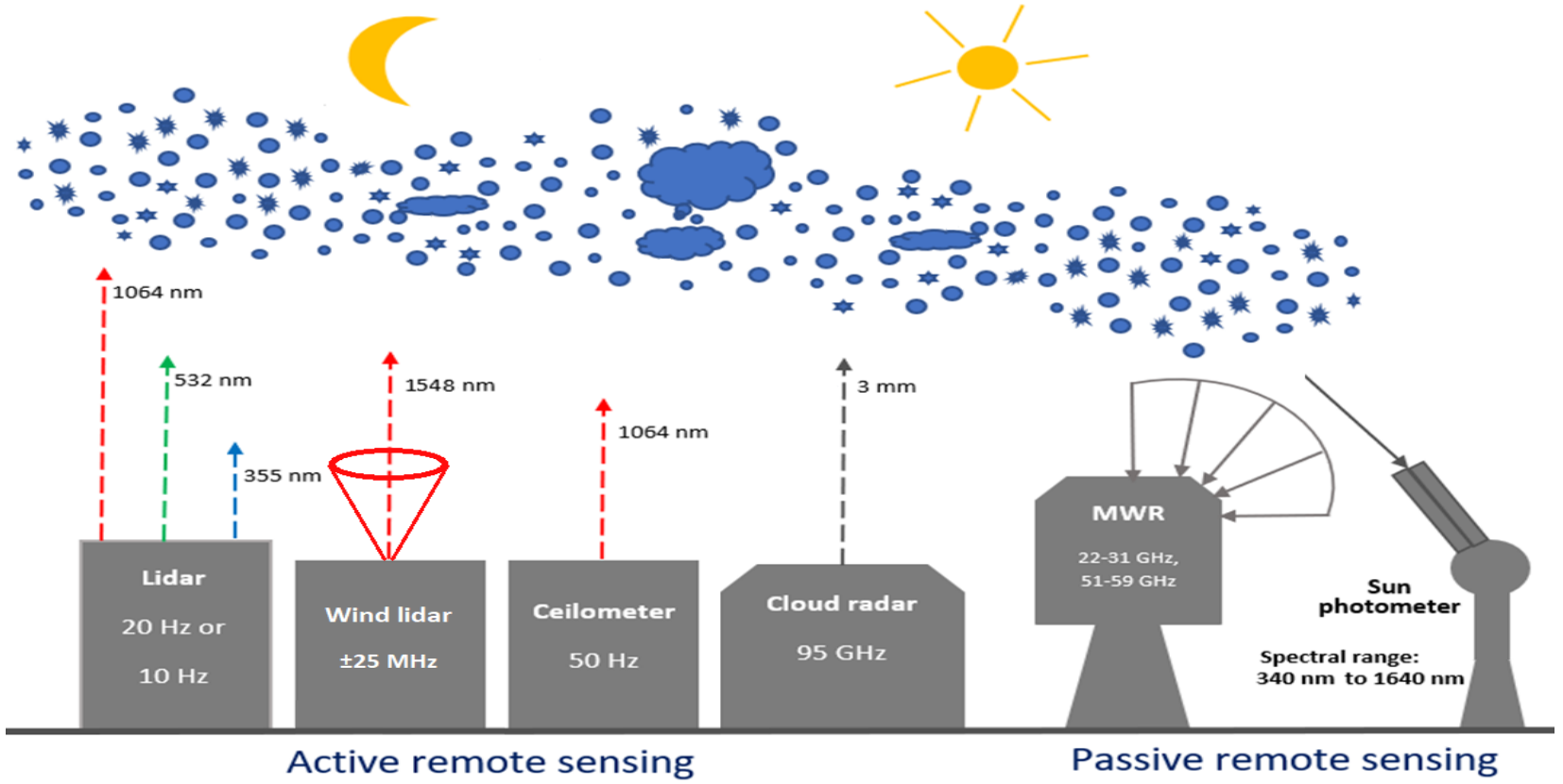
Ground based infrastructure in Romania

PROGRAMME OF THE EUROPEAN UNION

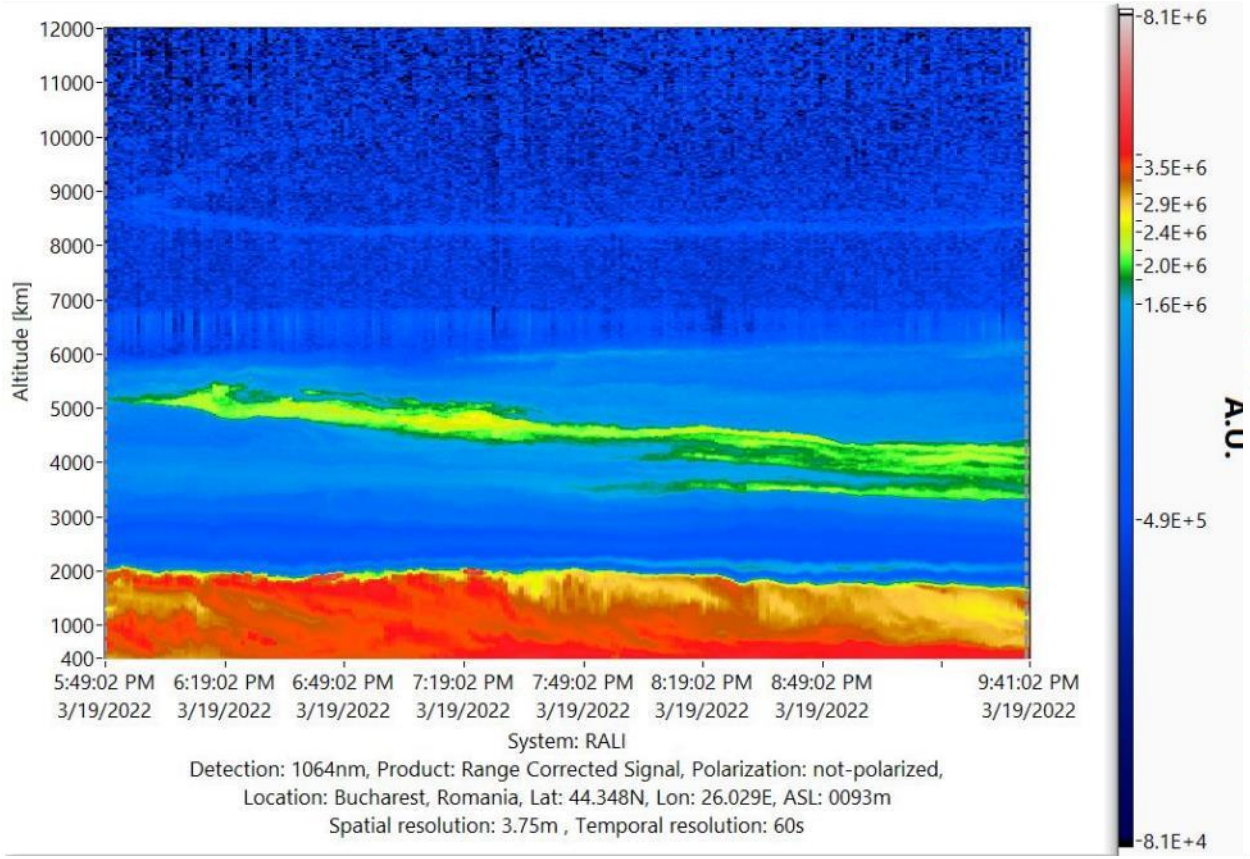
co-funded with

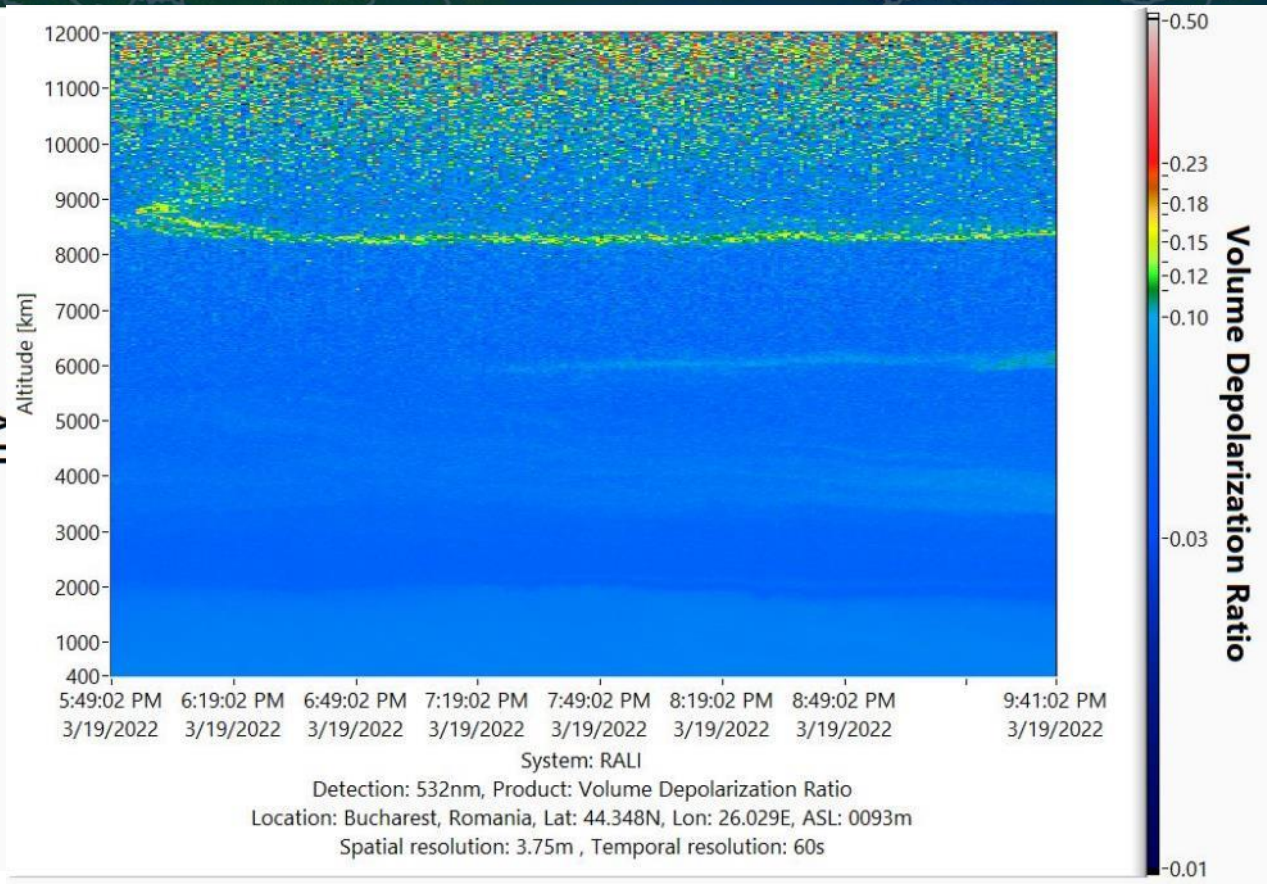
Multiwavelength Raman depolarization lidar

- extinction profiles in UV, VIS, IR
- Depolarization channels 532nm
- Raman Channels – nighttime
- Dynamic range 400-10000m



LIDAR DATA



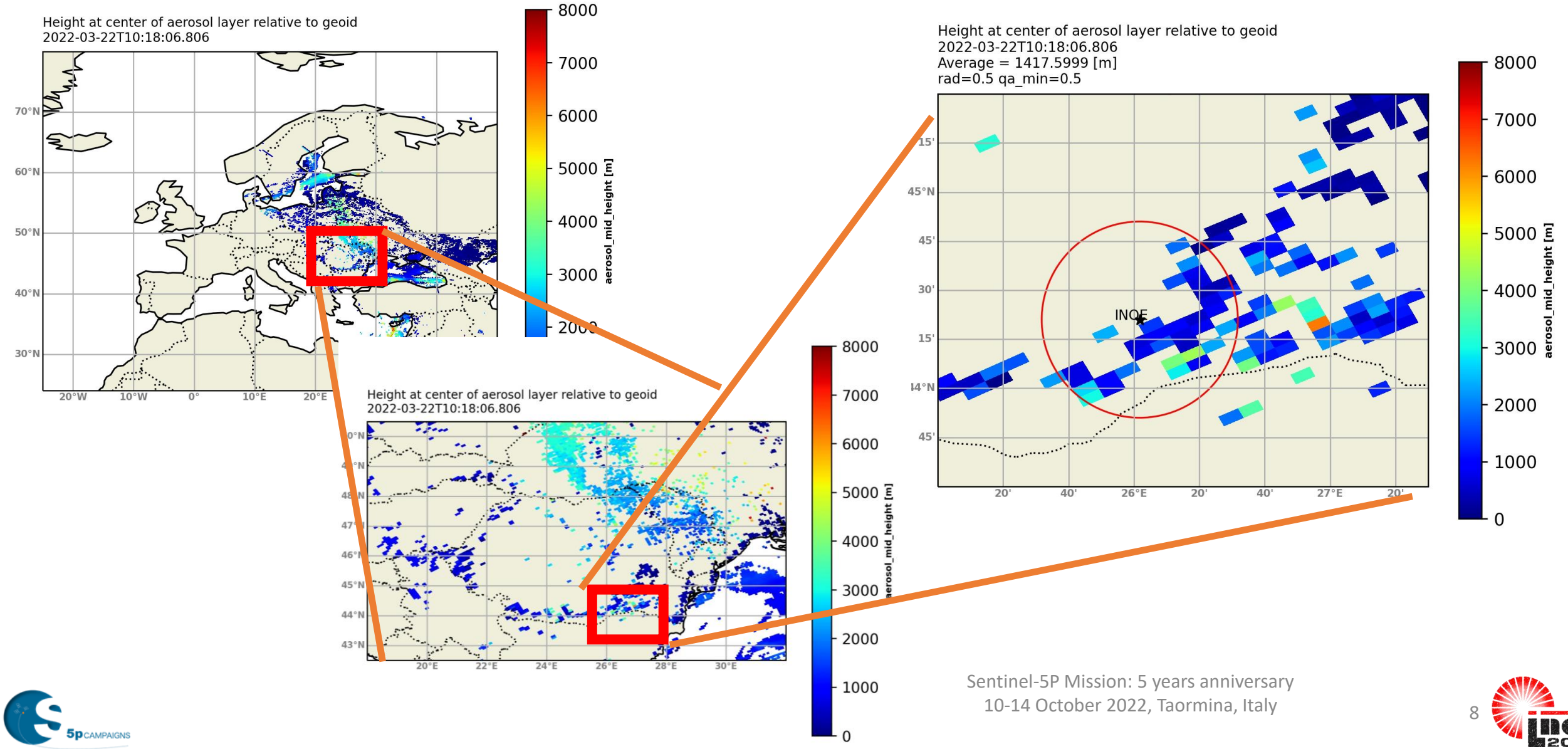


- geometrical properties: layer base, layer top, layer thickness can be calculated from the lidar signals
- Aerosol type in the layer- NATALI software (Nicolae et al., 2019)

ALH product S5p-ATDB

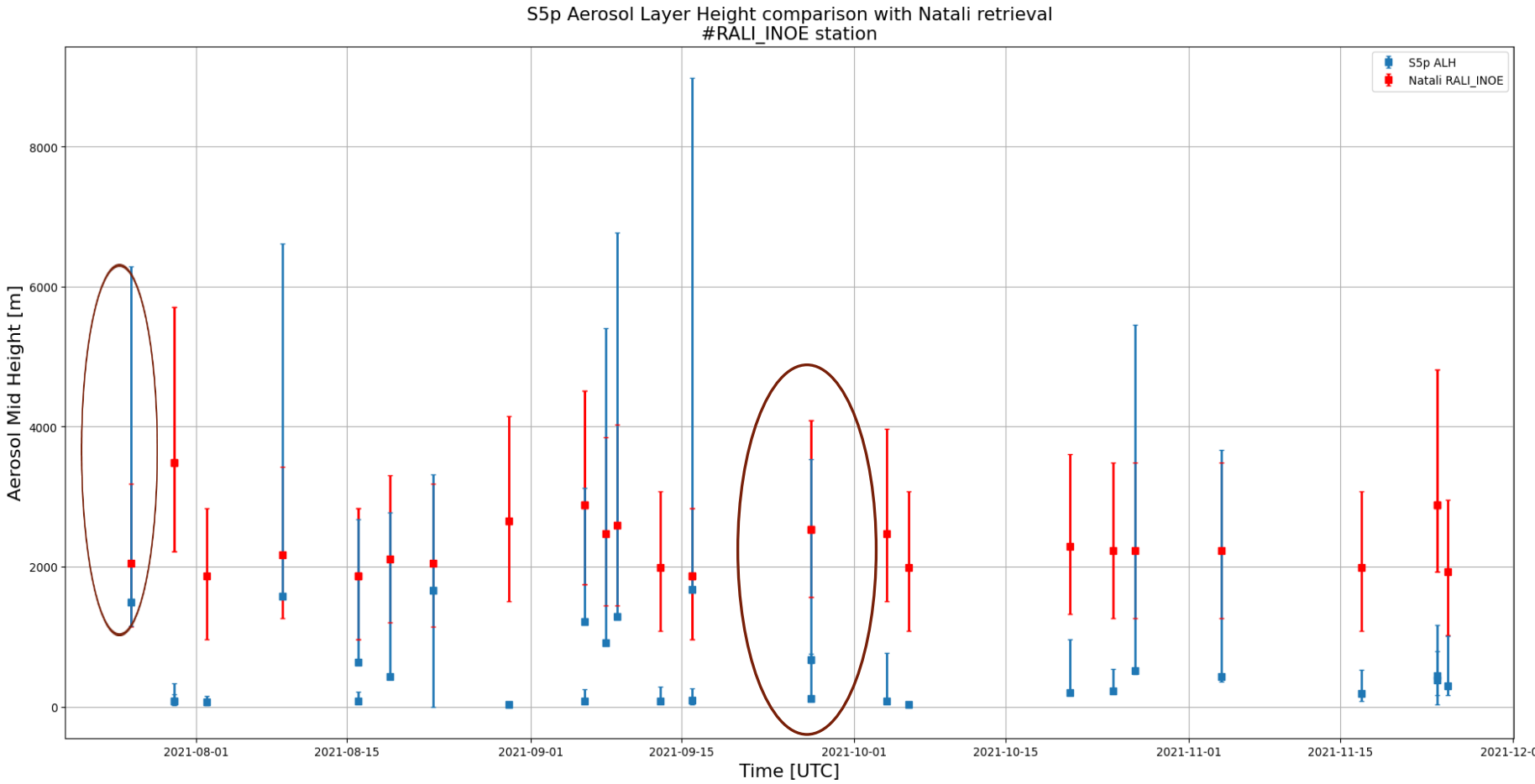
- S5P/TROPOMI Aerosol Layer Height product –algorithm developed by KNMI: S5P L2_AER_LH data
- An aerosol layer is modeled as a layer of particles with an associated aerosol optical thickness
- The baseline algorithm assumes that aerosols are uniformly distributed in a single layer with a fixed pressure thickness and a constant aerosol volume extinction coefficient and aerosol single scattering albedo.
- The reported pressure is the mid pressure of the layer.
- Example aerosol cases for which this profile parameterization is particularly suited are **free-tropospheric aerosols such as volcanic ash, desert dust and biomass burning aerosols**
- The retrieved Aerosol Layer Height parameter can then be interpreted as an average aerosol scattering height

TROPOMI ALH MAPS



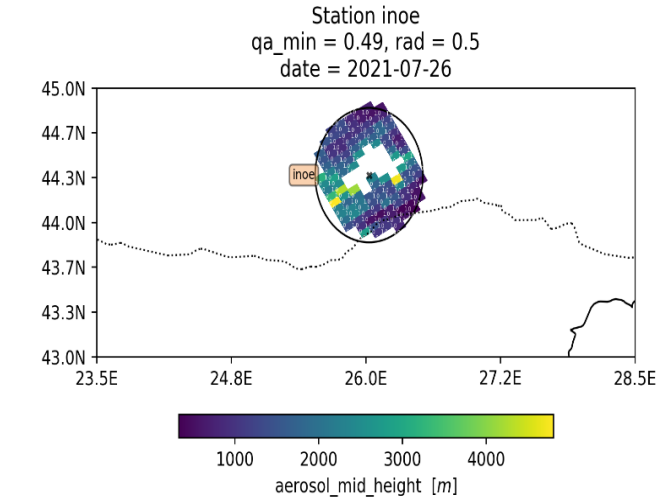
Intercomparison study

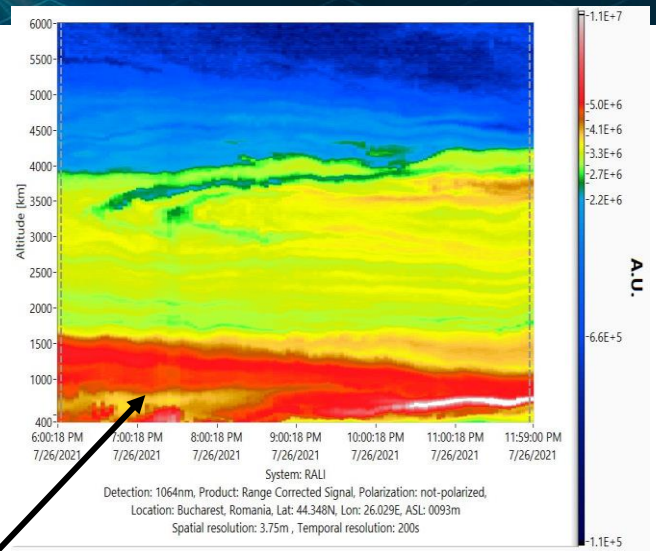
- the new improved algorithm released in July 2021 brings much more cases; (2018-2020 only about 15 in the S5P ALH data base)
- July-October 2021-**130** cases of layers over Magurele (INOE station) were retrieved from TROPOMI measurements, 83 cases are below 500m-
- 26 cases ALH/S5P quality assured-high temporal resolution observation with lidar and aerosol typing with NATALI software* for the identified layers

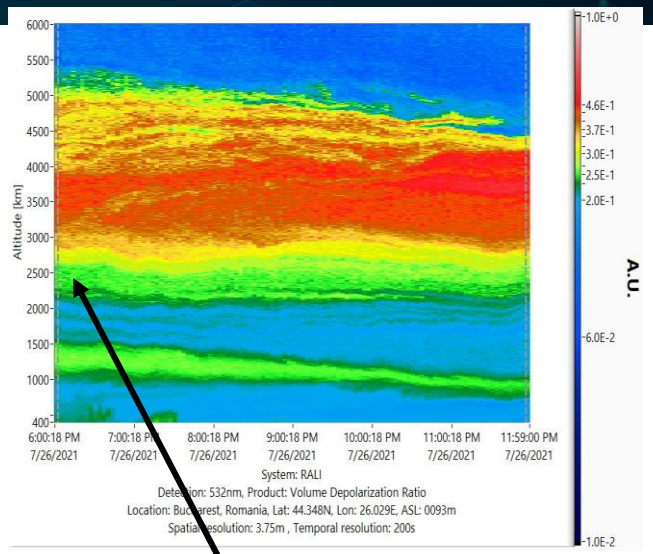


*Nicolae, D., Vasilescu, J., Talianu, C., Binietoglou, I., Nicolae, V., Andrei, S., and Antonescu, B.: A neural network aerosol-typing algorithm based on lidar data, Atmos. Chem. Phys., 18, 14511–14537, https://doi.org/10.5194/acp-18-14511-2018, 2018.

26.07.2021 and 09.27.2021-complex atmospheric scenes

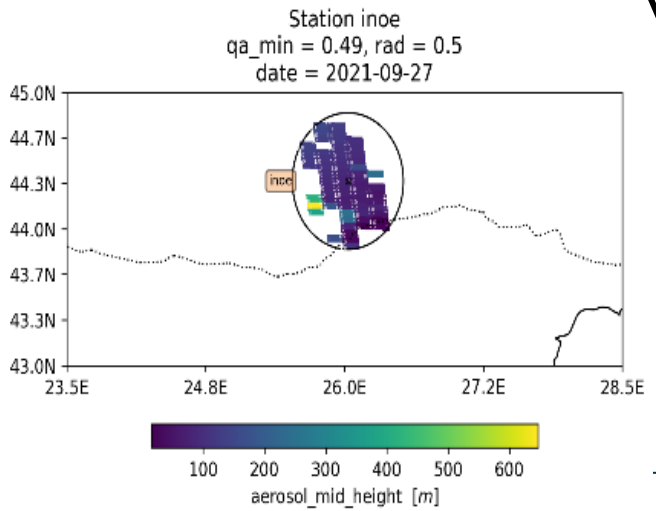


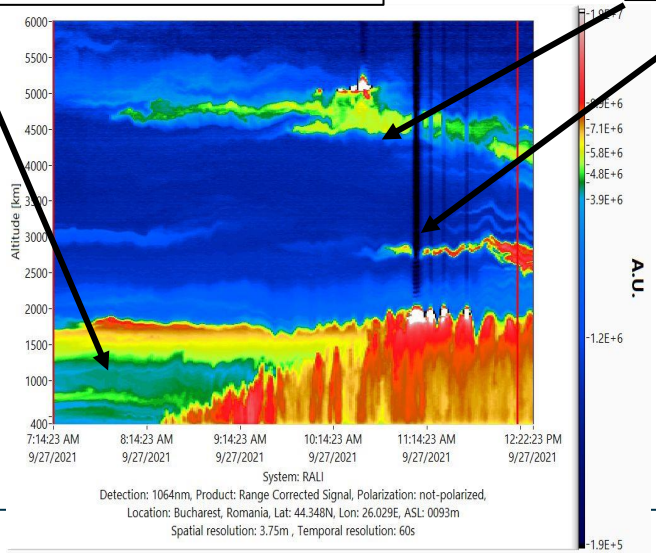


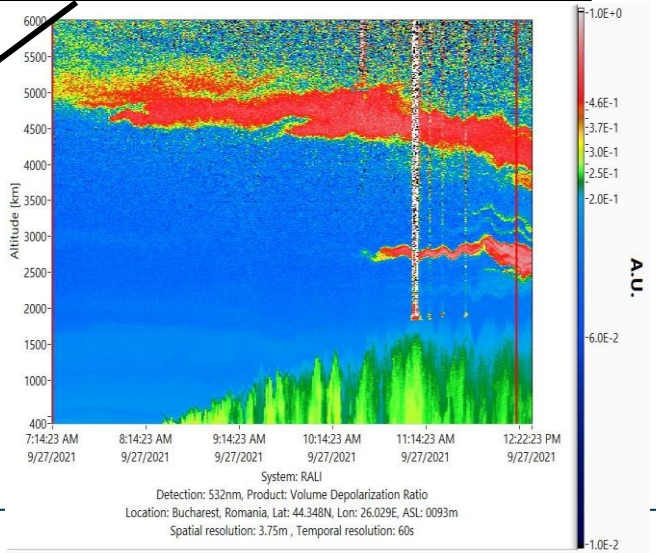


Smoke intrusion into the planetary boundary layer

Mineral particles in the free troposphere





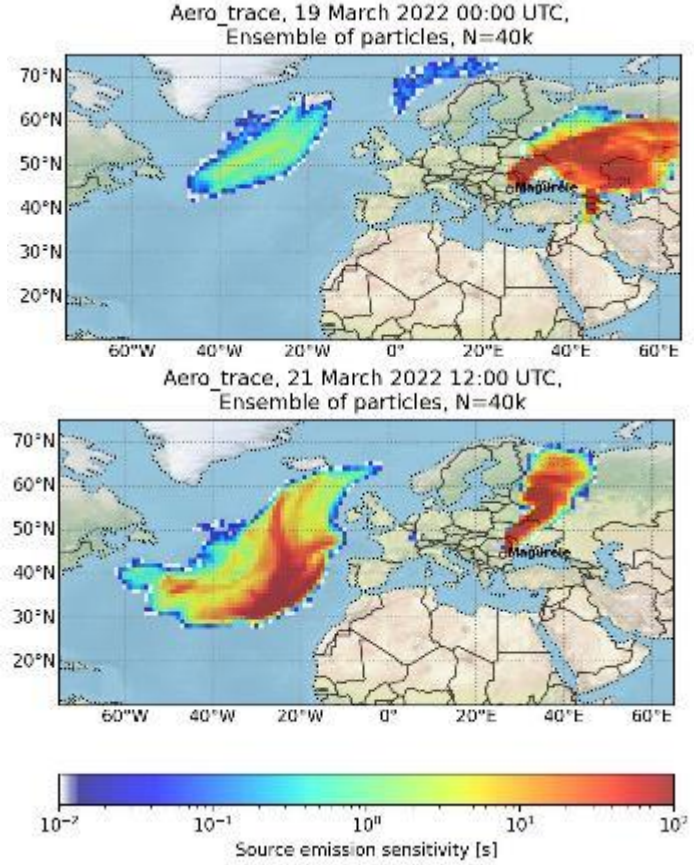


Case study March 2022

14-23 of March 2022

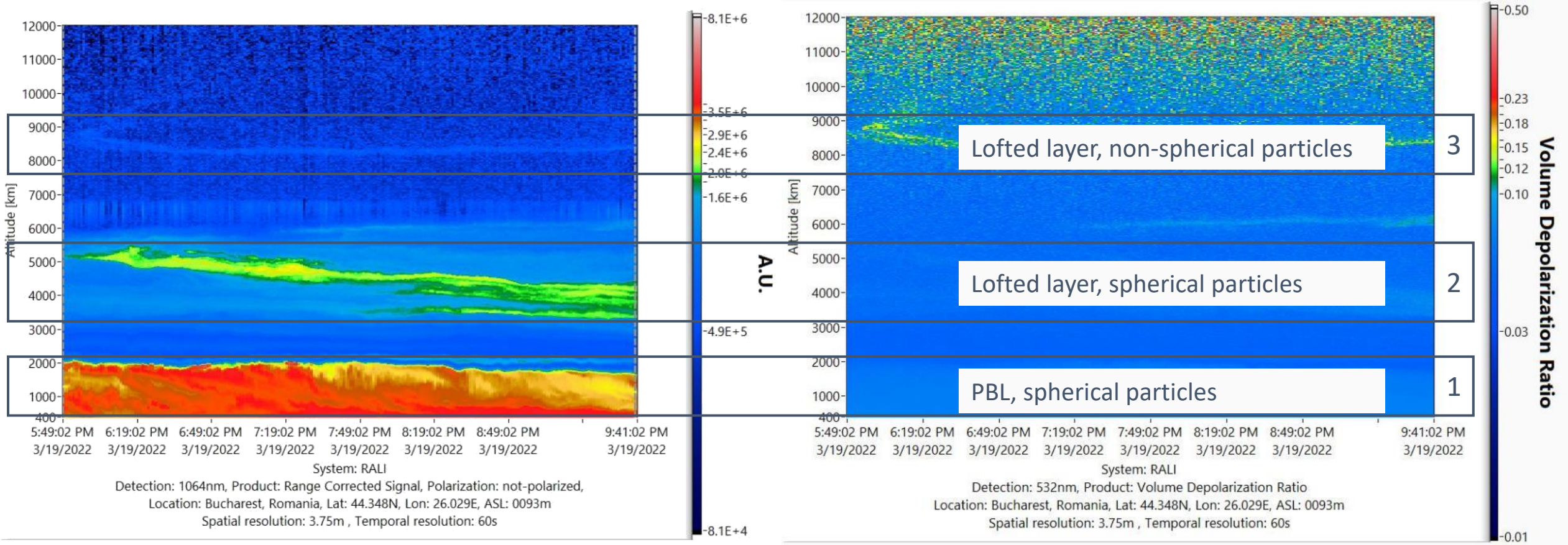
Meteo: steady high-pressure system centred over Ukraine, north-easterly flow at MARS

FLEXPART: predominant sources in Ukraine & Atlantic ocean

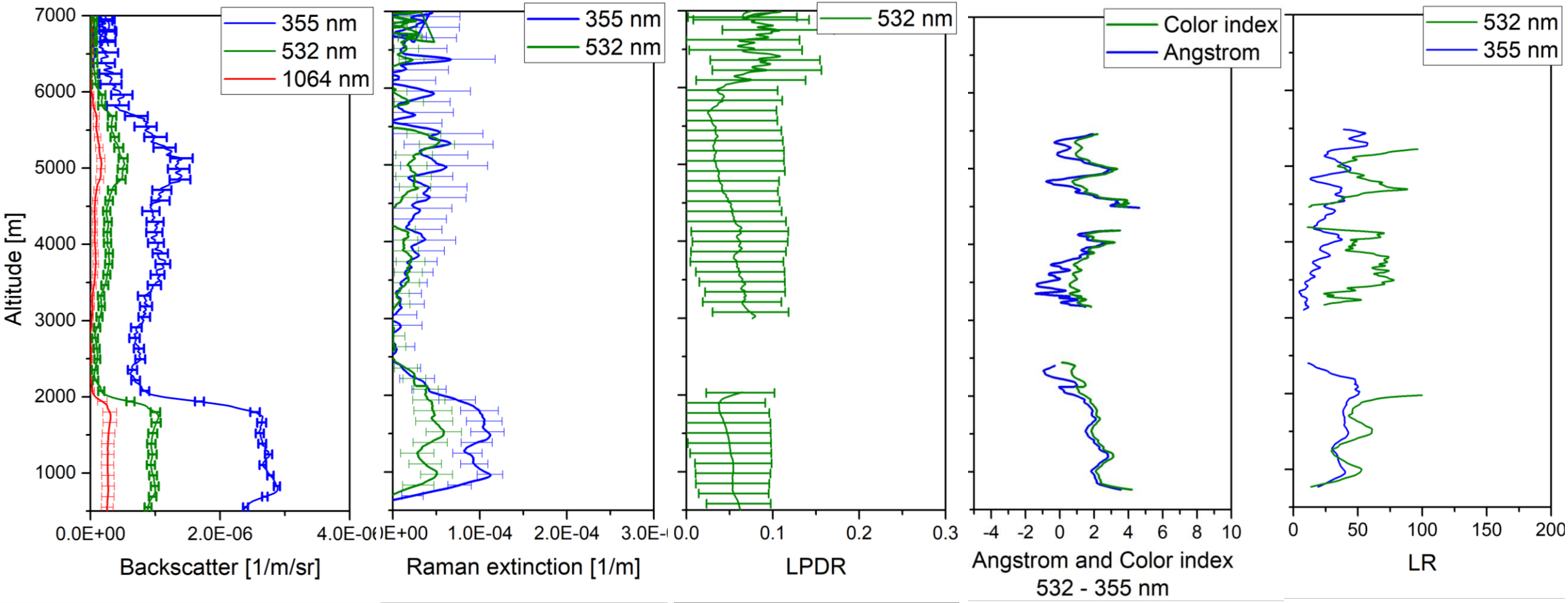


FLEXPART: ensemble of particles arriving @ MARS

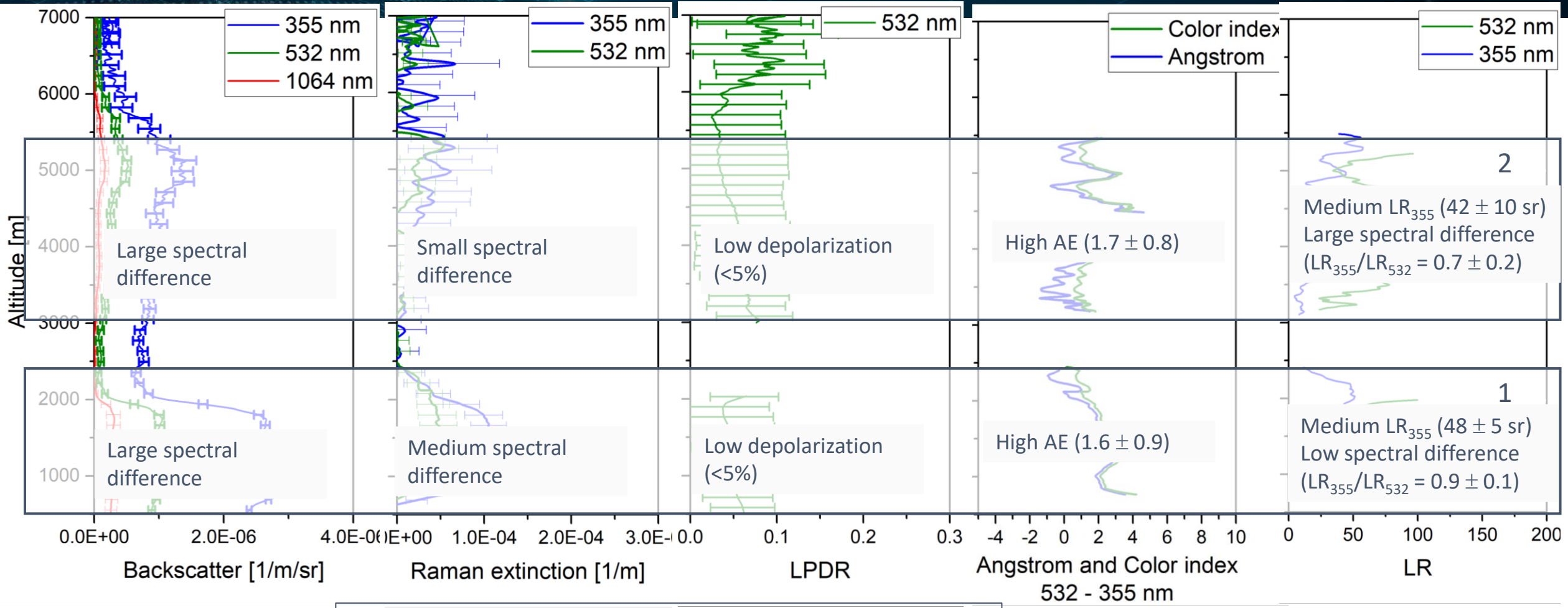
Lidar


Altitude [km]
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
400
5:49:02 PM 3/19/2022
6:19:02 PM 3/19/2022
6:49:02 PM 3/19/2022
7:19:02 PM 3/19/2022
7:49:02 PM 3/19/2022
8:19:02 PM 3/19/2022
8:49:02 PM 3/19/2022
9:41:02 PM 3/19/2022
System: RALI
Detection: 1064nm, Product: Range Corrected Signal, Polarization: not-polarized,
Location: Bucharest, Romania, Lat: 44.348N, Lon: 26.029E, ASL: 0093m
Spatial resolution: 3.75m , Temporal resolution: 60s
8.1E+6
3.5E+6
2.9E+6
2.4E+6
2.0E+6
1.6E+6
4.9E+5
8.1E+4
A.U.
Lofted layer, non-spherical particles
3
Lofted layer, spherical particles
2
PBL, spherical particles
1
Altitude [km]
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
400
5:49:02 PM 3/19/2022
6:19:02 PM 3/19/2022
6:49:02 PM 3/19/2022
7:19:02 PM 3/19/2022
7:49:02 PM 3/19/2022
8:19:02 PM 3/19/2022
8:49:02 PM 3/19/2022
9:41:02 PM 3/19/2022
System: RALI
Detection: 532nm, Product: Volume Depolarization Ratio
Location: Bucharest, Romania, Lat: 44.348N, Lon: 26.029E, ASL: 0093m
Spatial resolution: 3.75m , Temporal resolution: 60s
0.50
0.23
0.18
0.15
0.12
0.10
0.03
0.01
Volume Depolarization Ratio

Detailed analysis of the aerosol



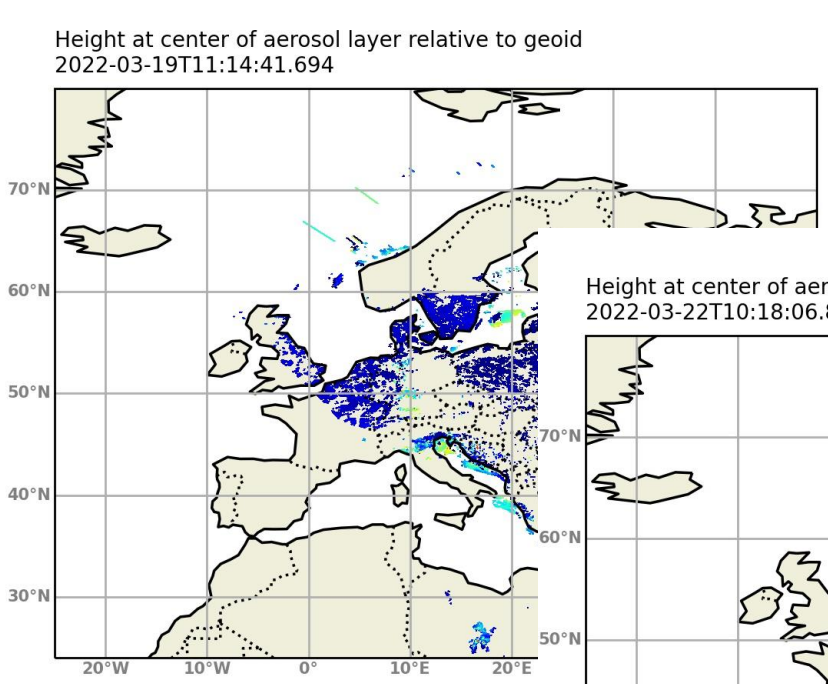
Lidar

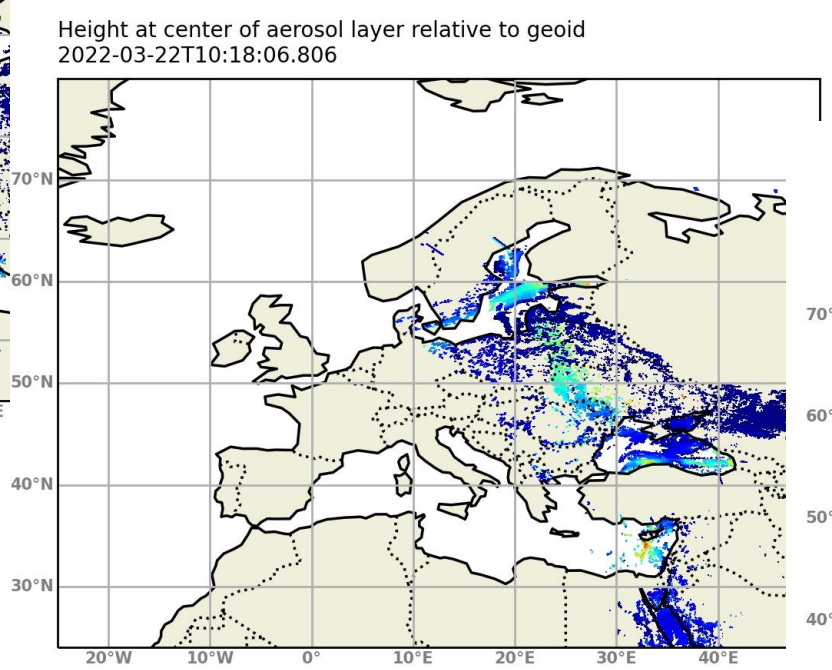


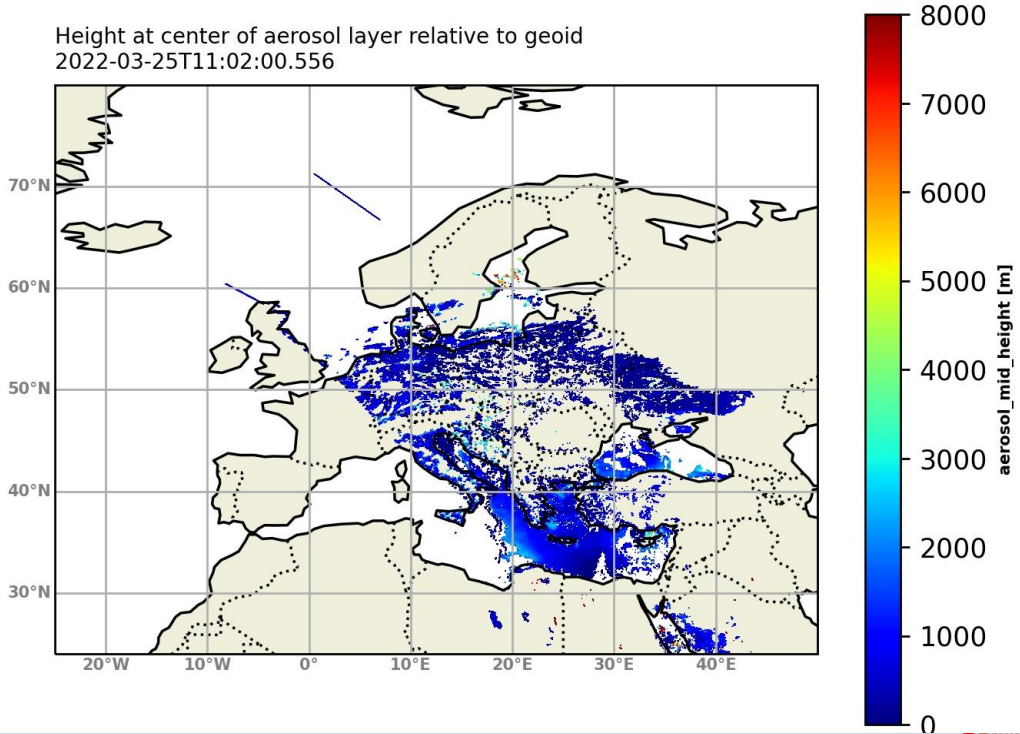
Aerosol typing: smoke mixed with continental

- Layer 1: local influence + long-range transported smoke
- Layer 2: long-range transported smoke + marine

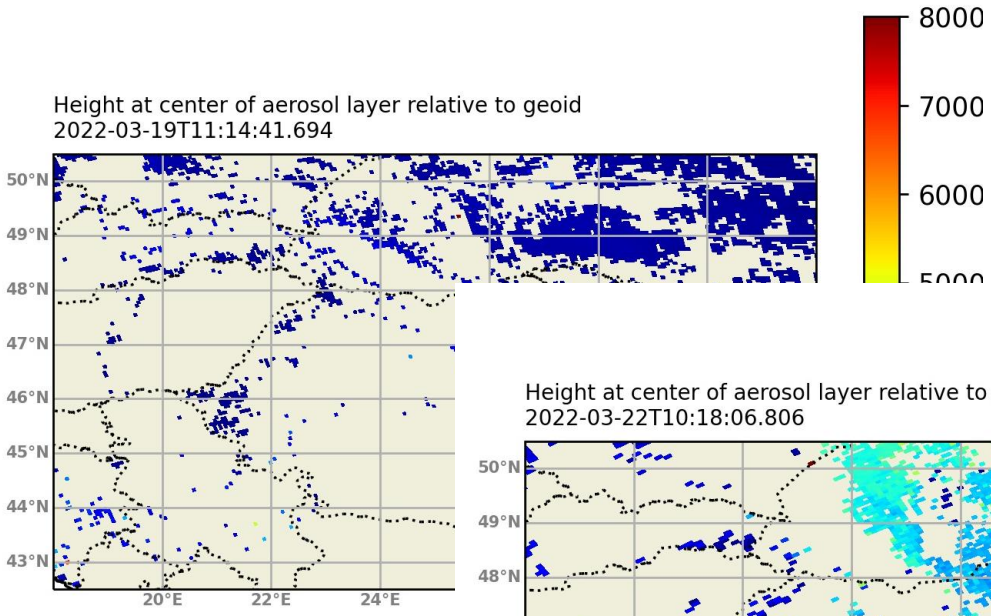
ALH S5P 19-25.03.2022 Europe

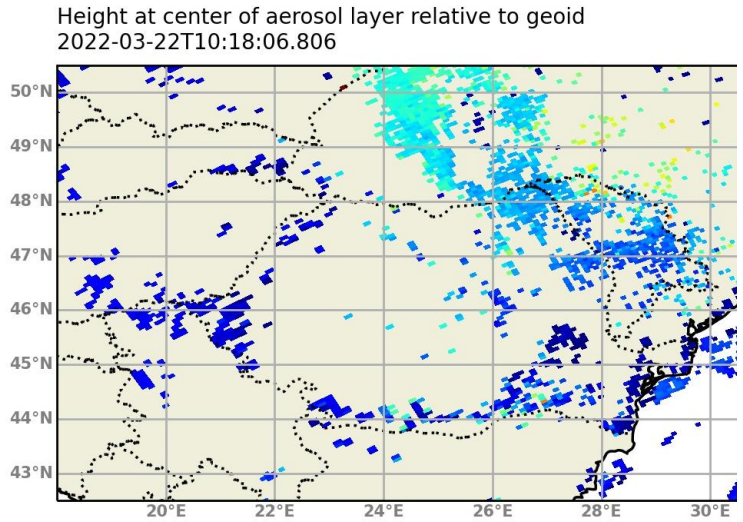


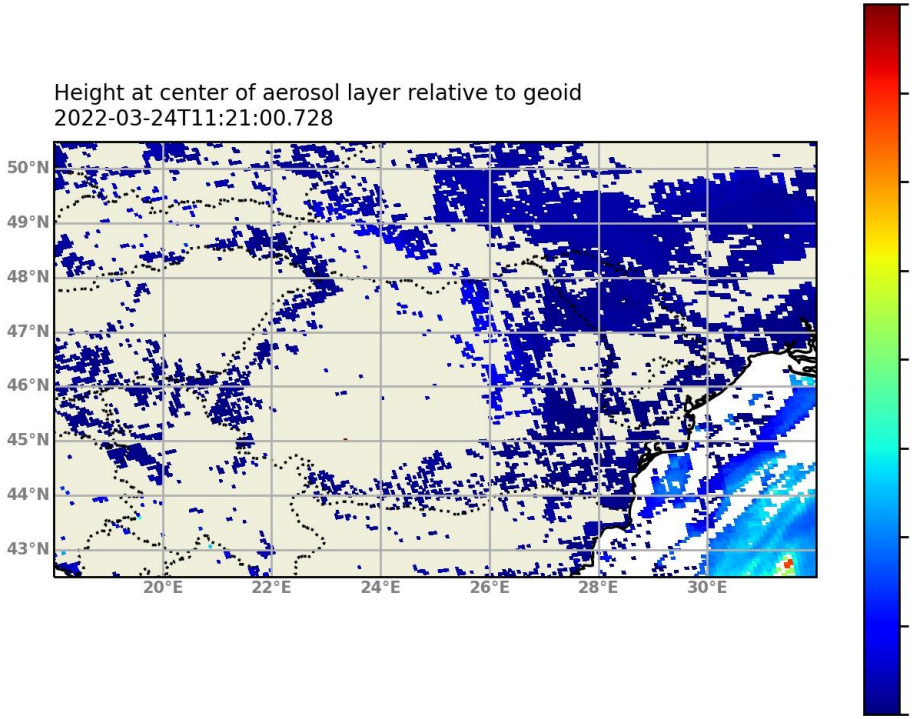




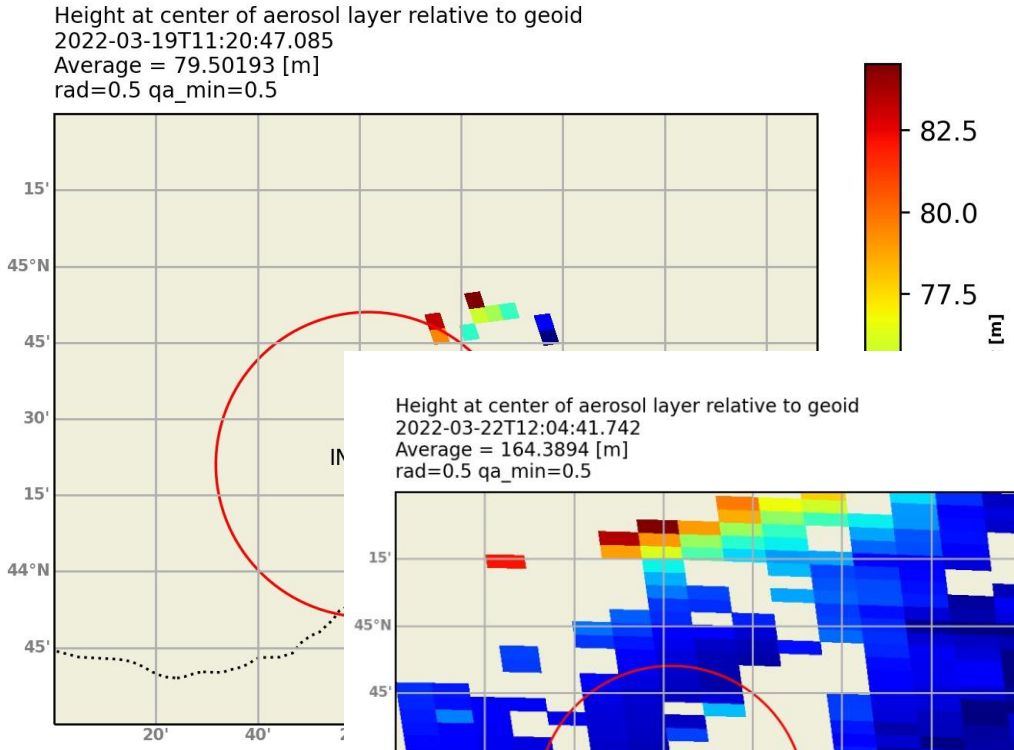
ALH S5P 19-25.03.2022 Romania

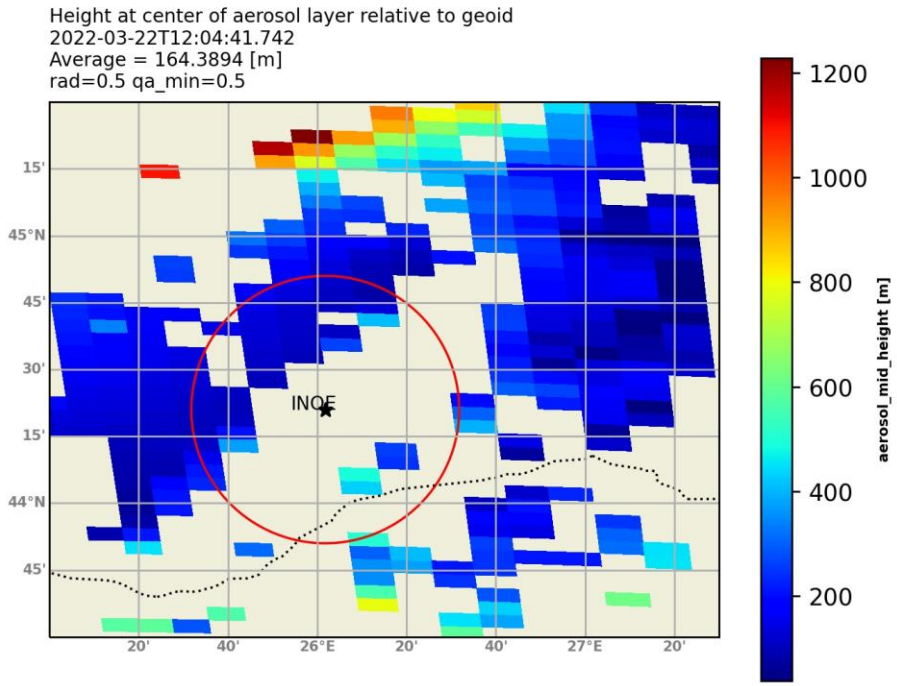


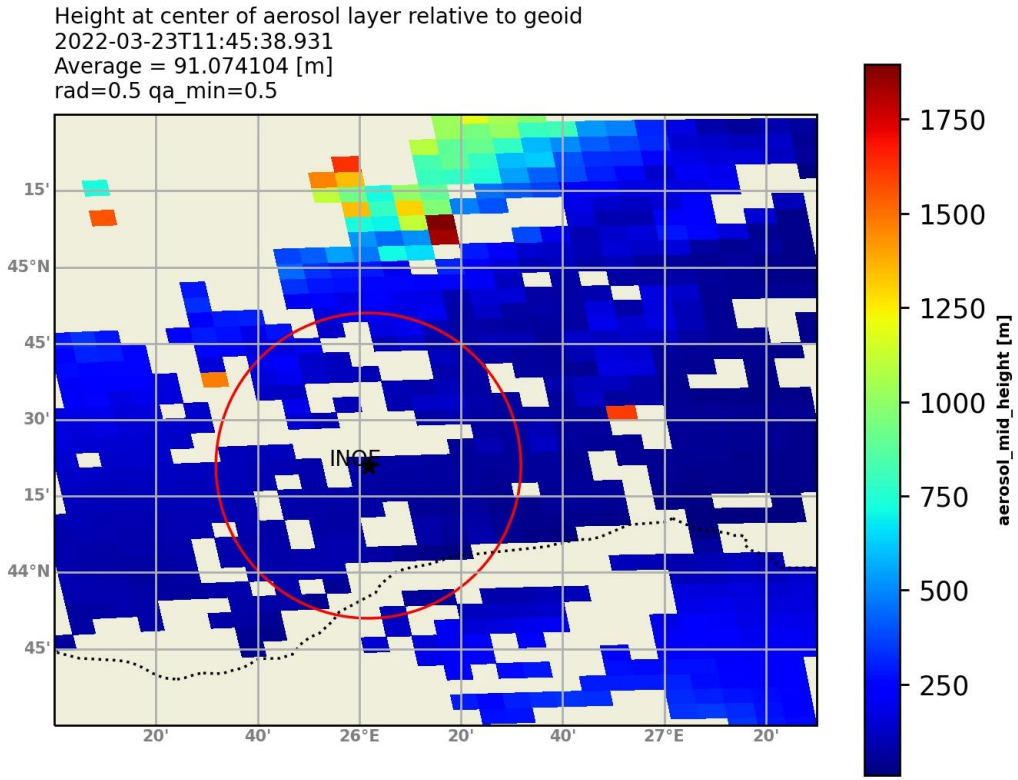




ALH S5P 19-25.03.2022 Bucharest







ALH S5P over land

- the TROPOMI ALH product has decreased capabilities over land compared to over the sea surfaces since, over bright surfaces, the retrieval algorithm becomes increasingly sensitive to errors in the surface albedo features (Griffin et al., 2020)
- "The algorithm needs to be extended to account for boundary layer aerosols. We anticipate extending DISAMAR to simultaneously fit properties of **two atmospheric intervals**, one representing an elevated layer and on representing the boundary layer" ATDB ALH TROPOMI

Summary

PROGRAMME OF THE EUROPEAN UNION

co-funded with esa

Procedure for ALH data intercomparison ground-satellite

Find in the S5p data base all layers 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

At this point aerosol layer heights derived from lidar measurements over land are rarely matched by the ones derived from TROPOMI

- ❑ An important step forward will be the implementation in the ALH S5P retrieval the scheme to simultaneously fit properties of two atmospheric intervals, one representing an elevated layer and on representing the boundary layer.
- ❑ Further analysis will be done after the new satellite update of the algorithm

Thank you for your attention!

This work was supported by ESA through the Contract No. 4000132151/20/NL/FF/ab, SVANTE and by grants of the Romanian Ministry of Education and Research, Romanian National Core Program contract 18N/08.02.2019 and 18PFE/30.12.2021