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

## Presentation by Anca Nemuc, INOE

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



# Outline



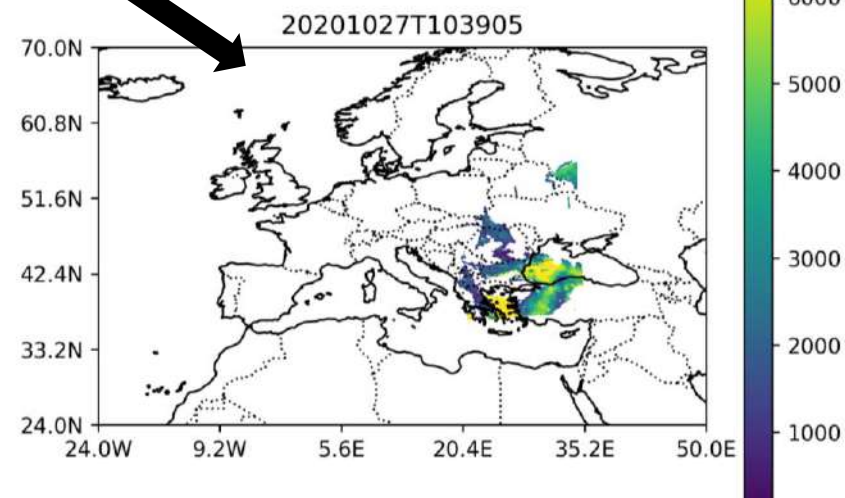
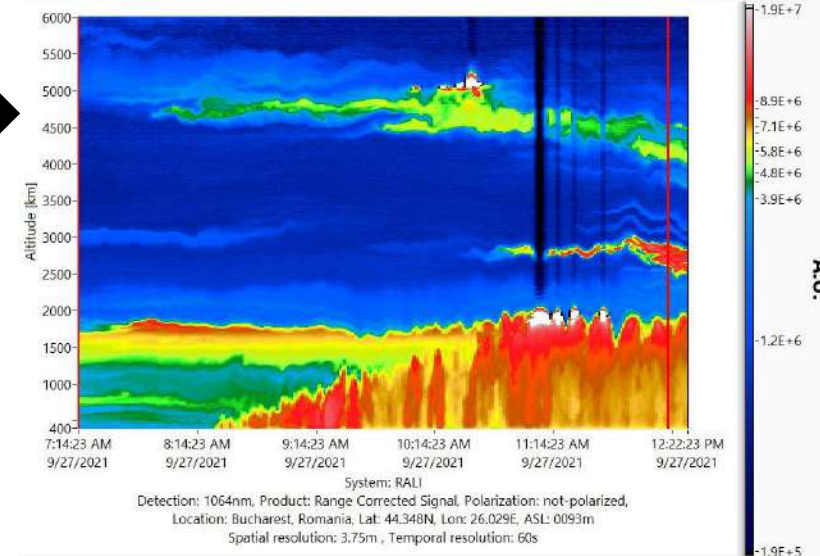
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- Aerosol layers from the ground based lidar
- Aerosol layers from TROPOMI
- Behind the scenes - comparison of the two views
- Case study
- Future work



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# 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



Fog



Wind and precipitation



Aerosols



Clouds



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# MARS = Magurele centre for Atmosphere and Radiation Studies



Precipitation

Clouds

# Ground based infrastructure in Romania



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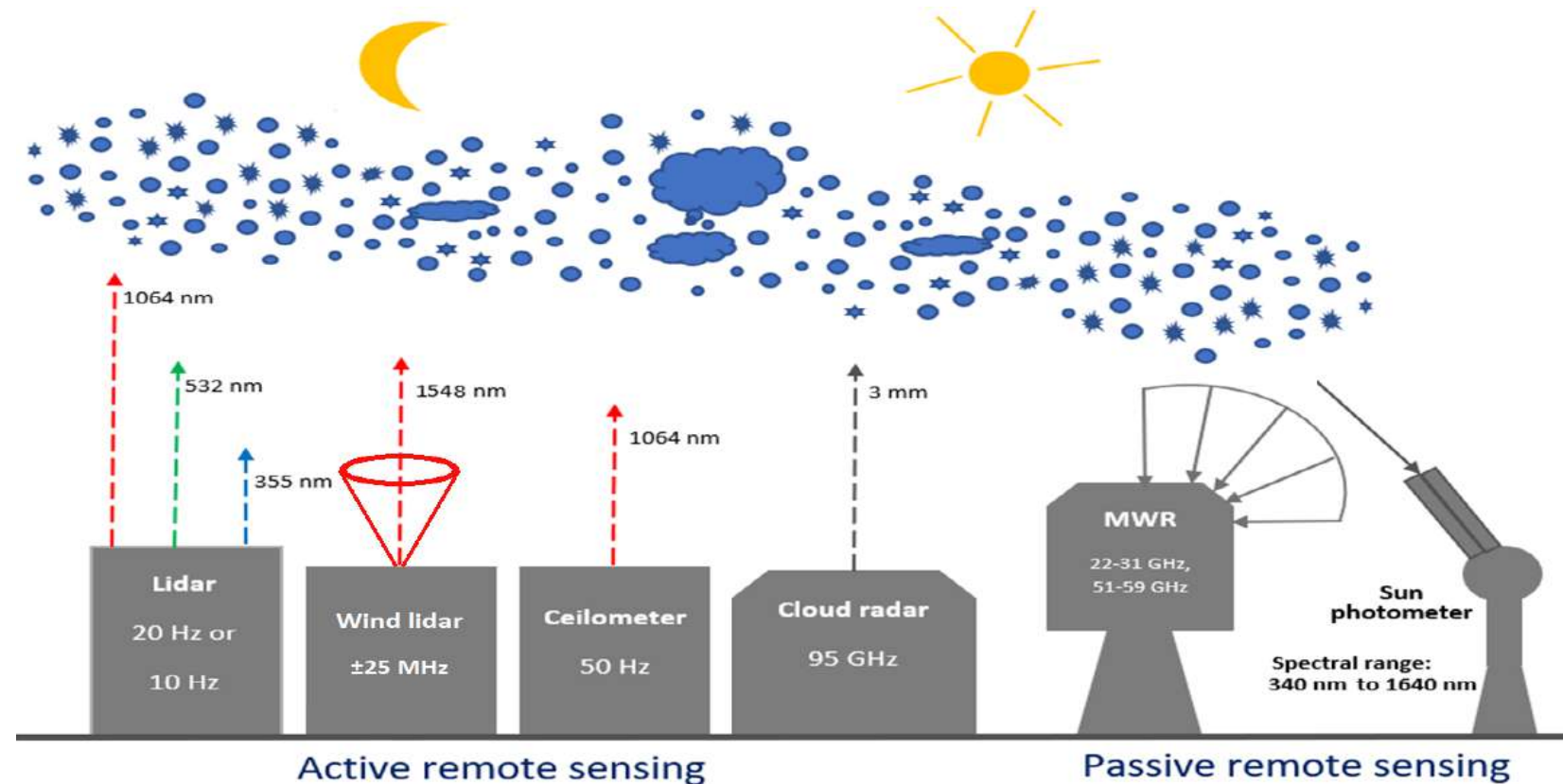


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## Multiwavelength Raman depolarization lidar

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



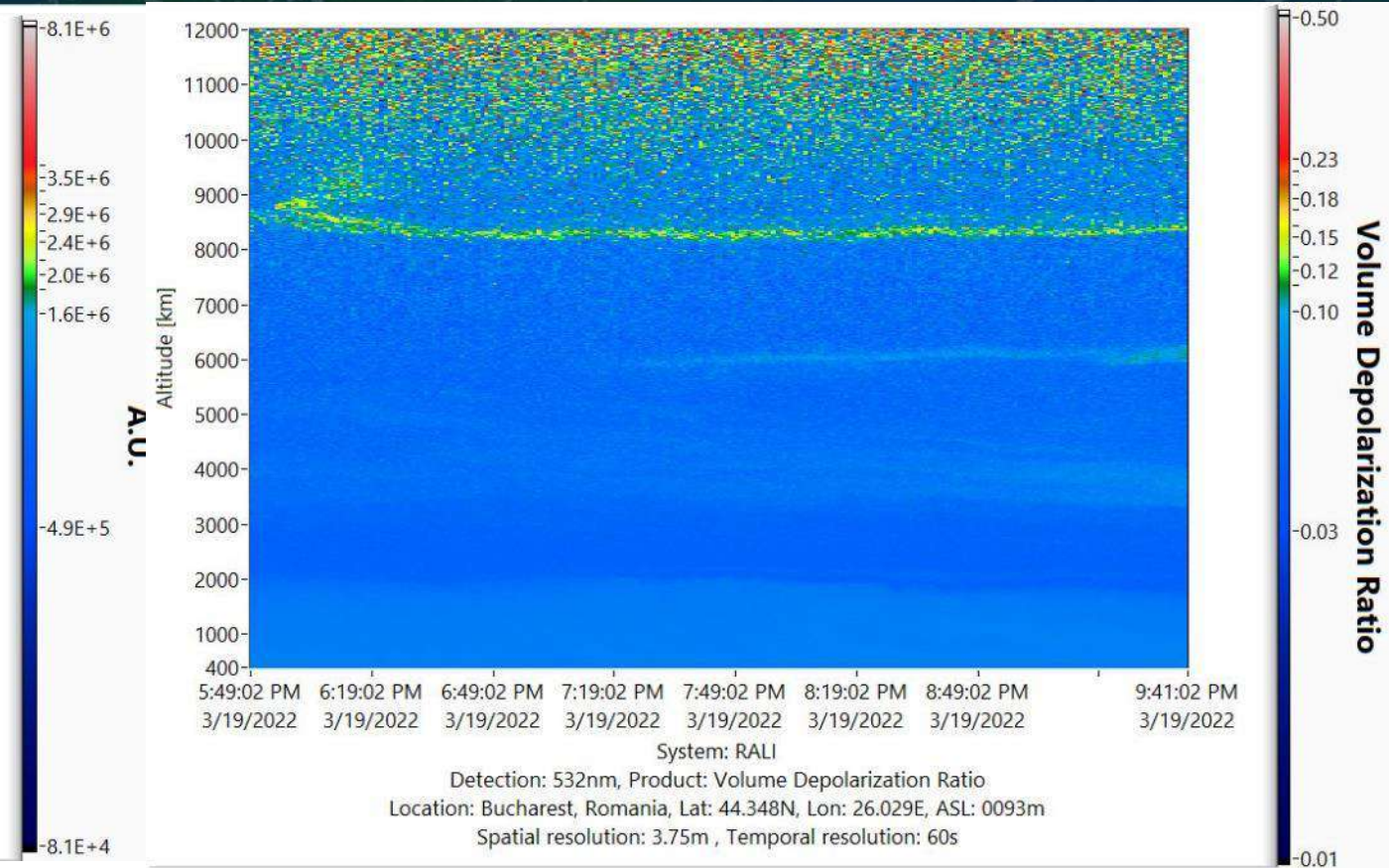
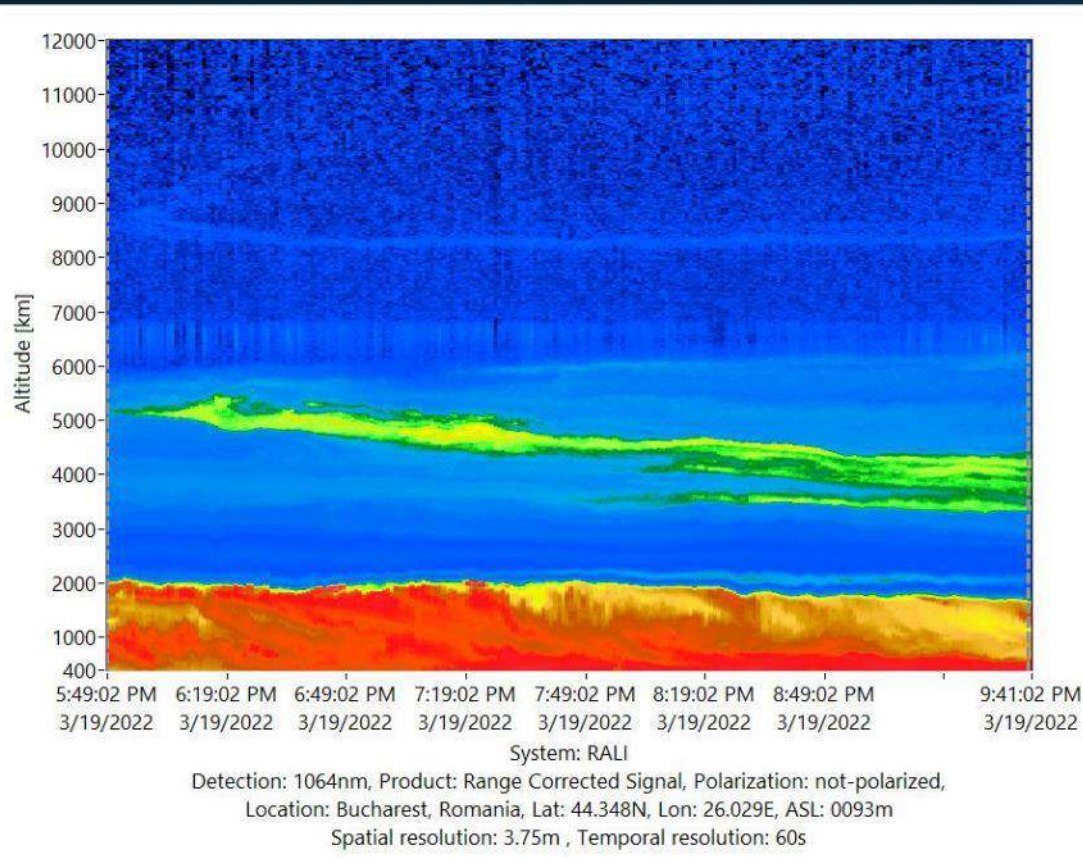
# LIDAR DATA



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- 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)

- **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



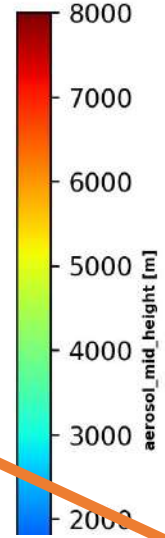
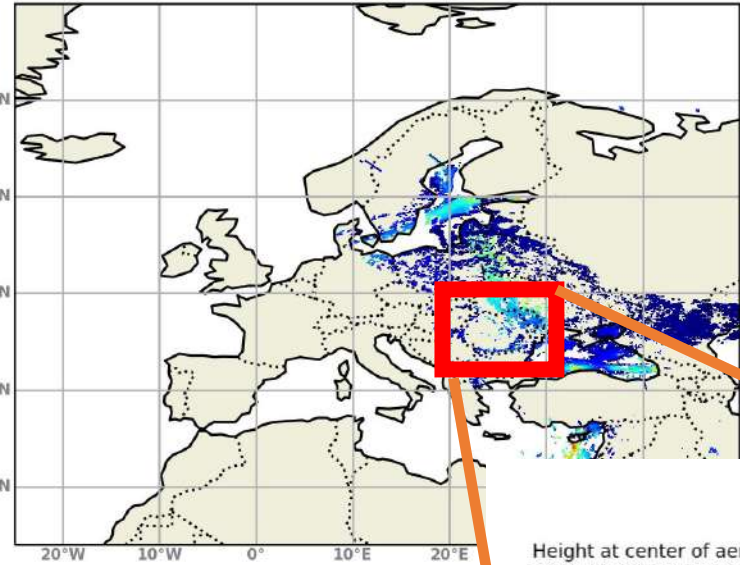
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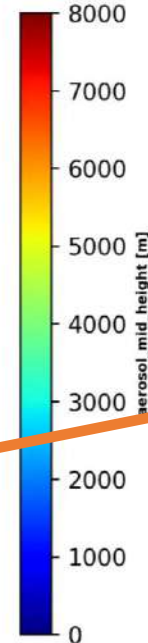
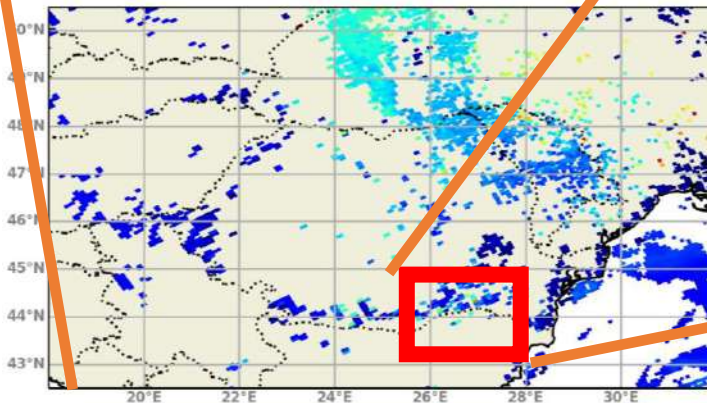
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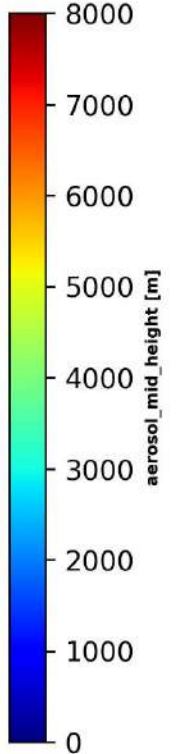
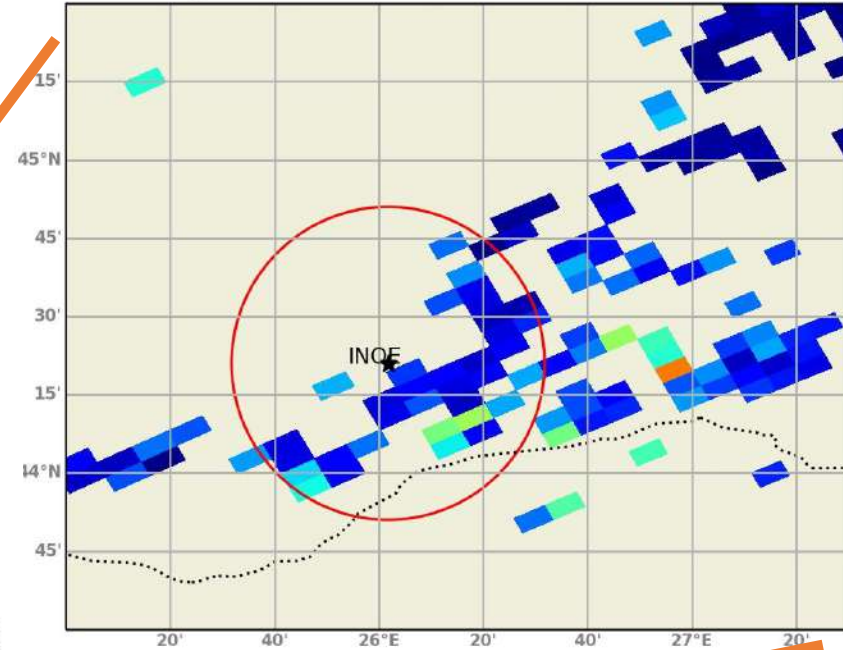
Height at center of aerosol layer relative to geoid  
2022-03-22T10:18:06.806



Height at center of aerosol layer relative to geoid  
2022-03-22T10:18:06.806



Height at center of aerosol layer relative to geoid  
2022-03-22T10:18:06.806  
Average = 1417.5999 [m]  
rad=0.5 qa\_min=0.5



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# Intercomparison study



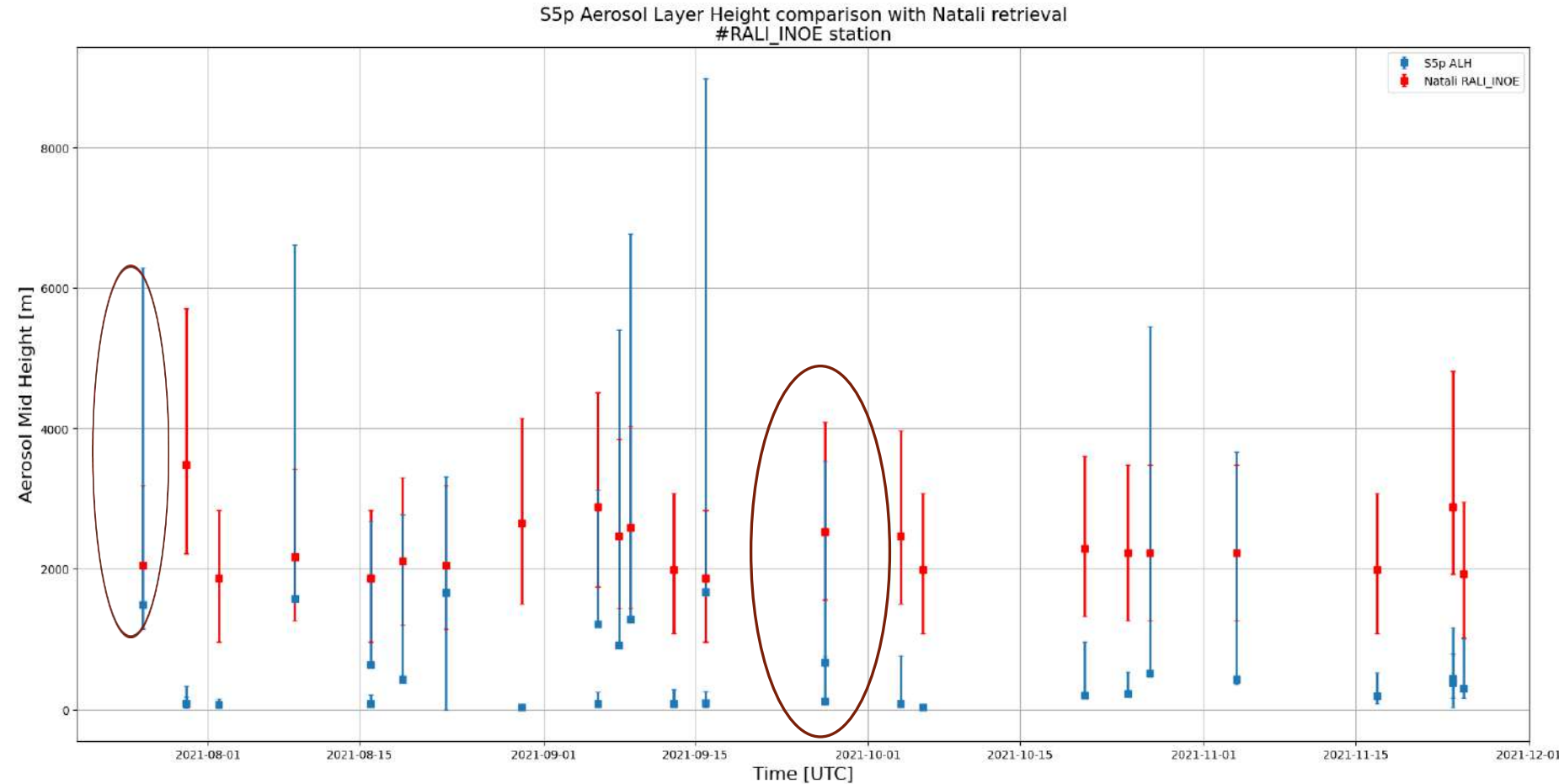
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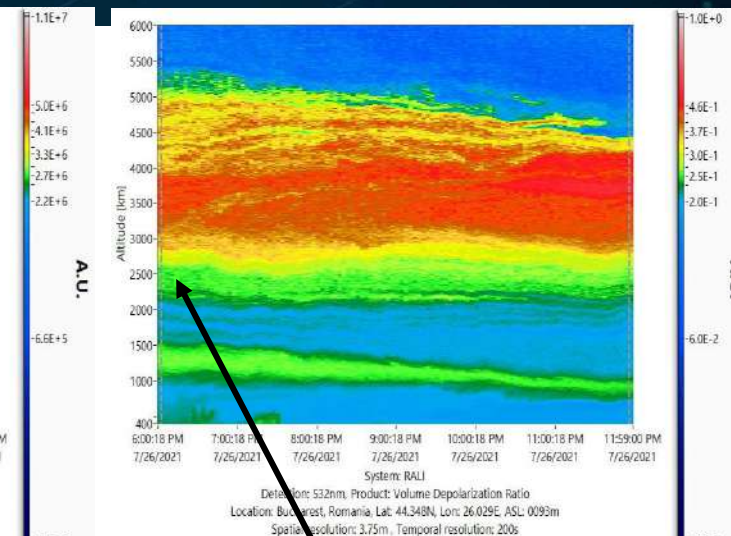
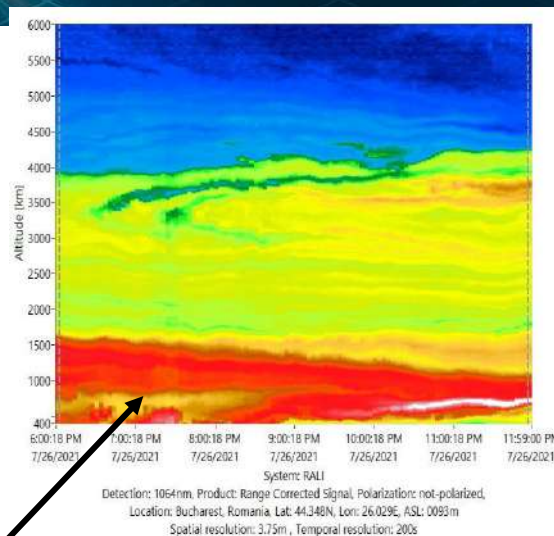
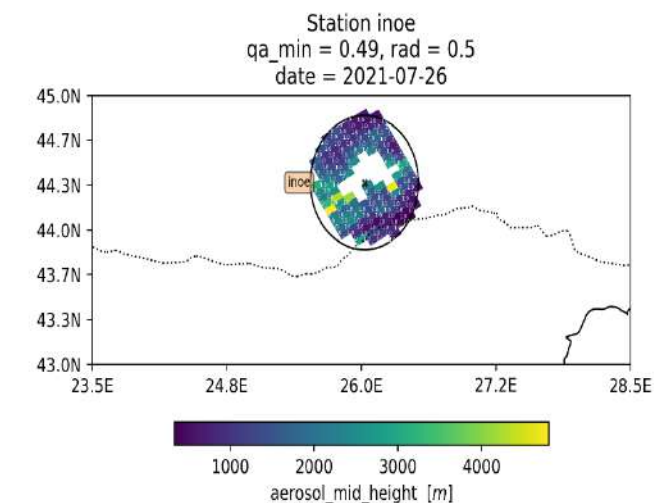


- the new improved algorithm released in July 2021 brings much more cases; (2018-2020 only about 15 in the S5P ALH data base)
- July-October 2021-**130** cases of layers over Magurele (INOE station) were retrieved from TROPOMI measurements, **83** cases are below 500m-
- **26 cases** ALH/S5P quality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



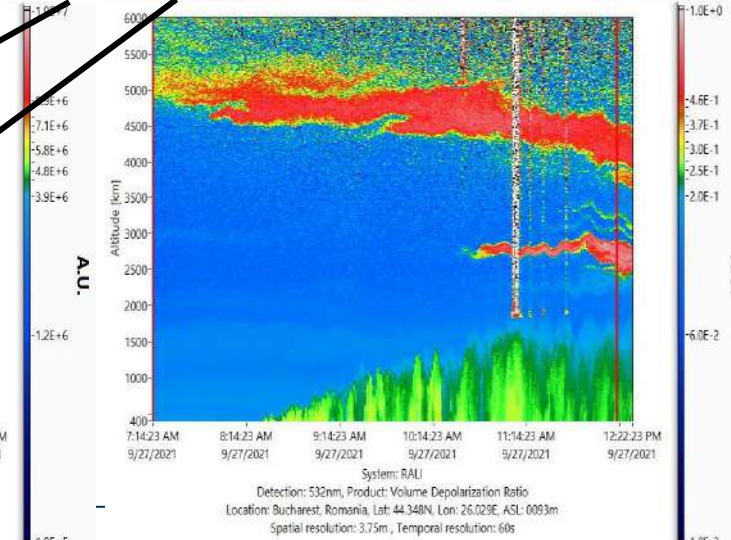
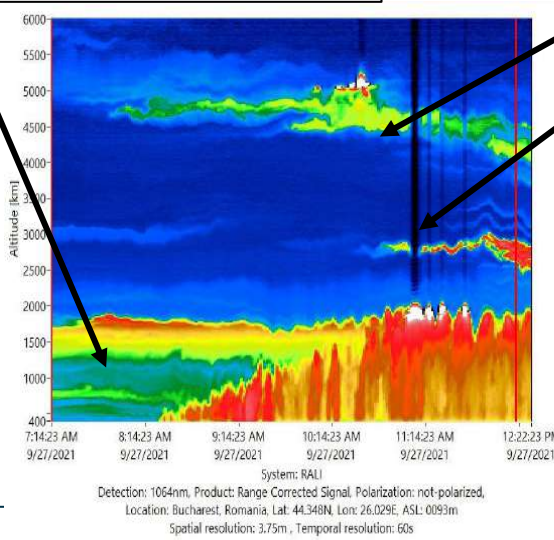
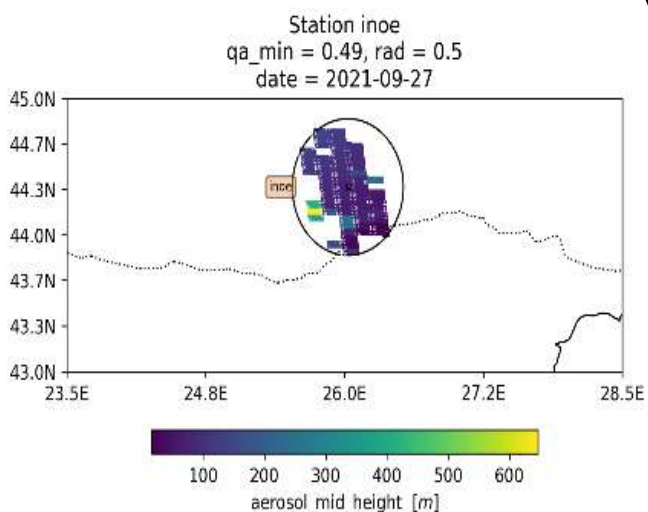
\*Nicolae, D., Vasilescu, J., Talianu, C., Binietoglou, I., Nicolae, V., Andrei, S., and Antonescu, B.: A neural network aerosol-typing algorithm based on lidar data, Atmos. Chem. Phys., 18, 14511–14537, <https://doi.org/10.5194/acp-18-14511-2018>, 2018.

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Smoke intrusion into the planetary boundary layer

Mineral particles in the free troposphere



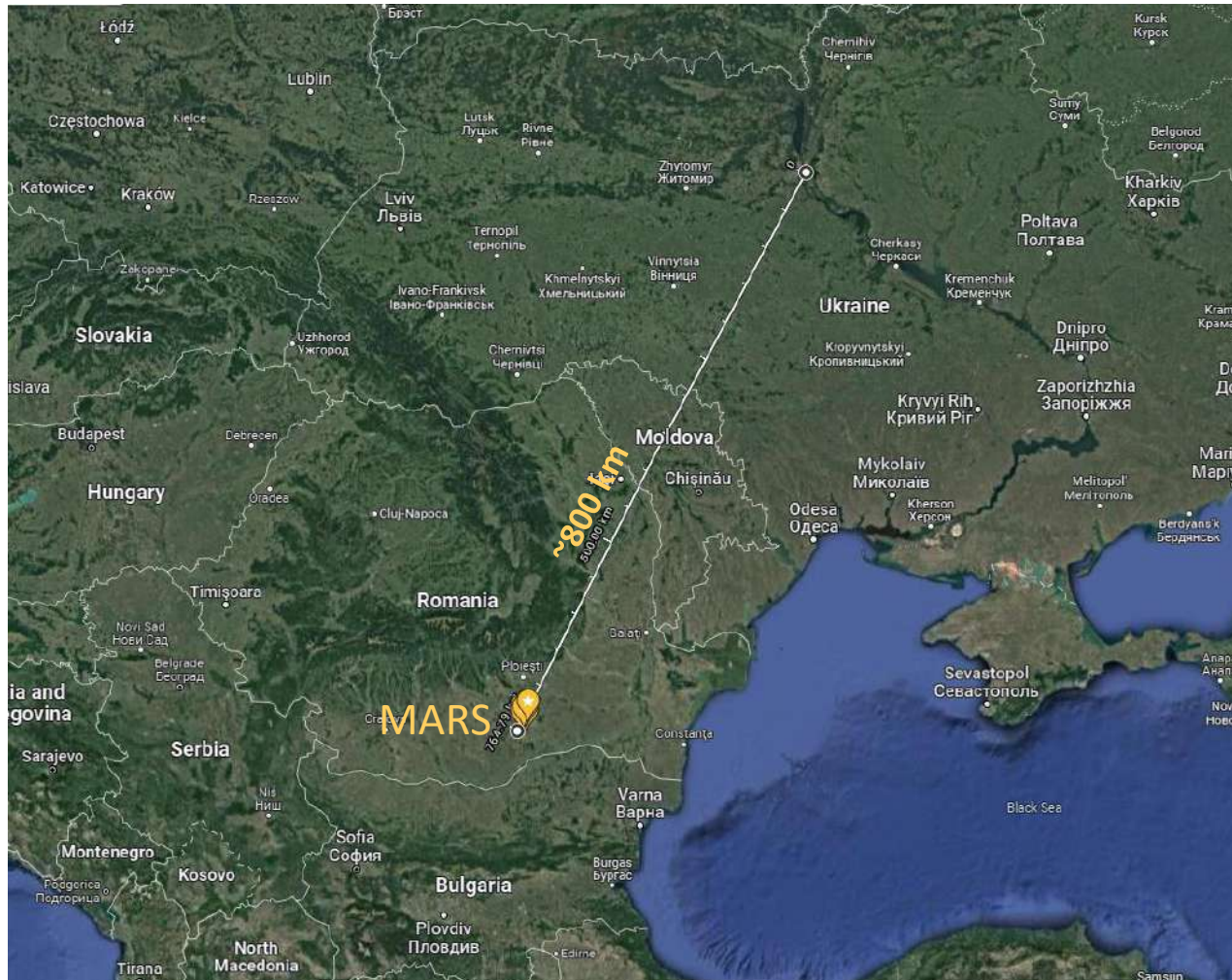
# Case study March 2022



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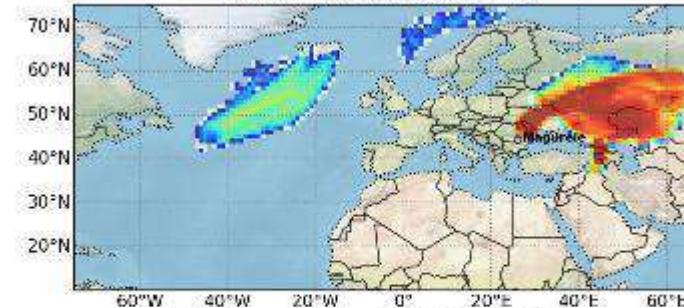


## 14-23 of March 2022

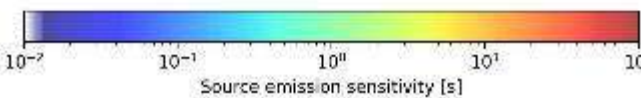
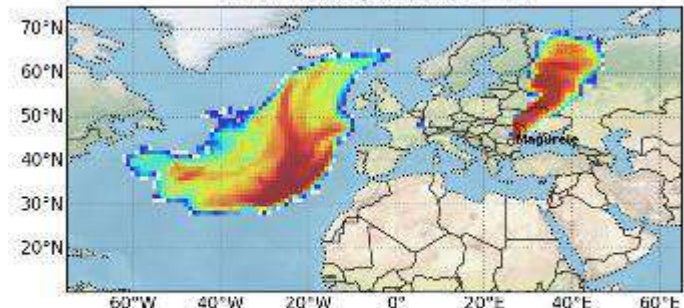
Meteo: steady high-pressure system centred over Ukraine, north-easterly flow at MARS

FLEXPART: predominant sources in Ukraine & Atlantic ocean

Aero\_trace, 19 March 2022 00:00 UTC, Ensemble of particles, N=40k



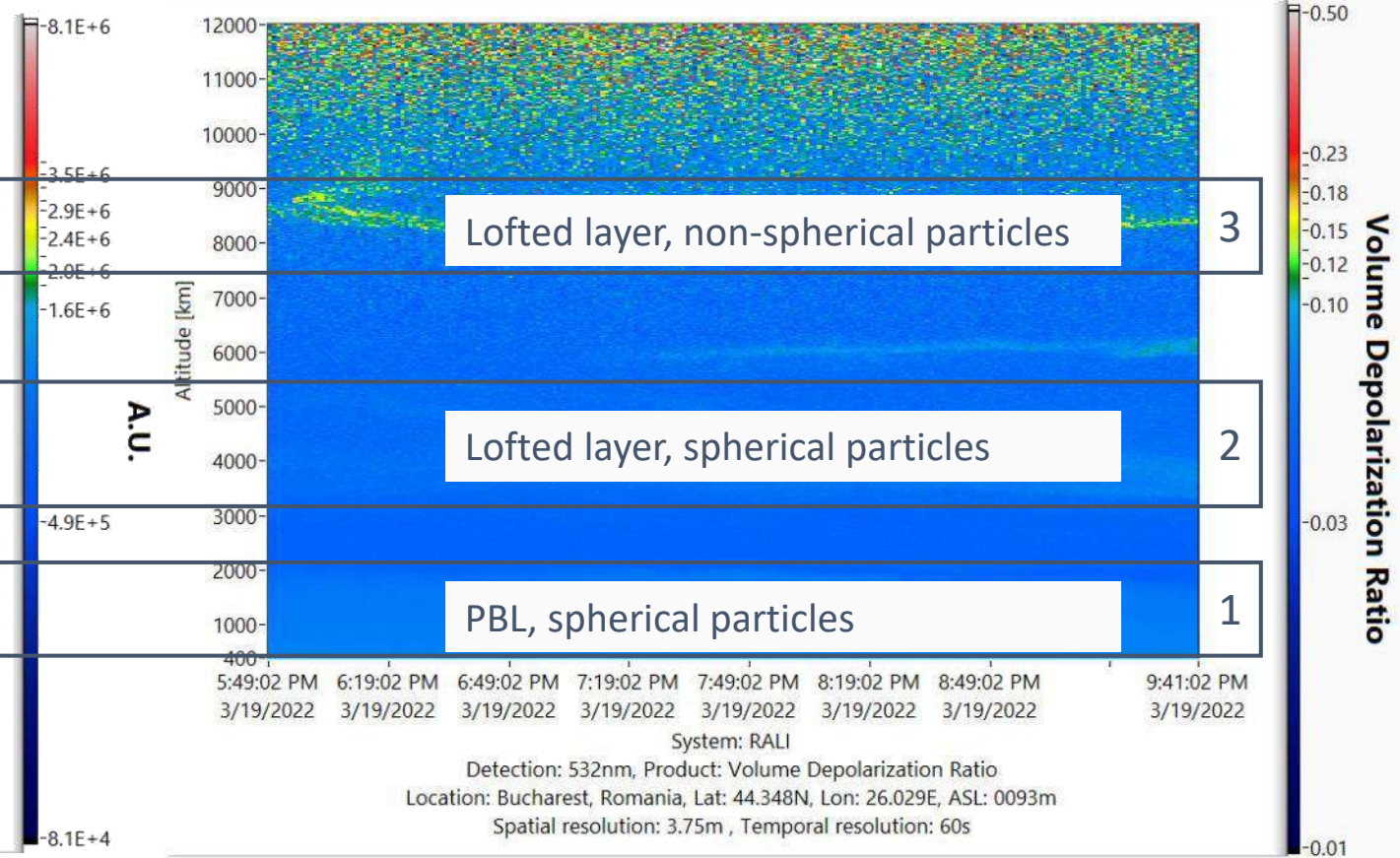
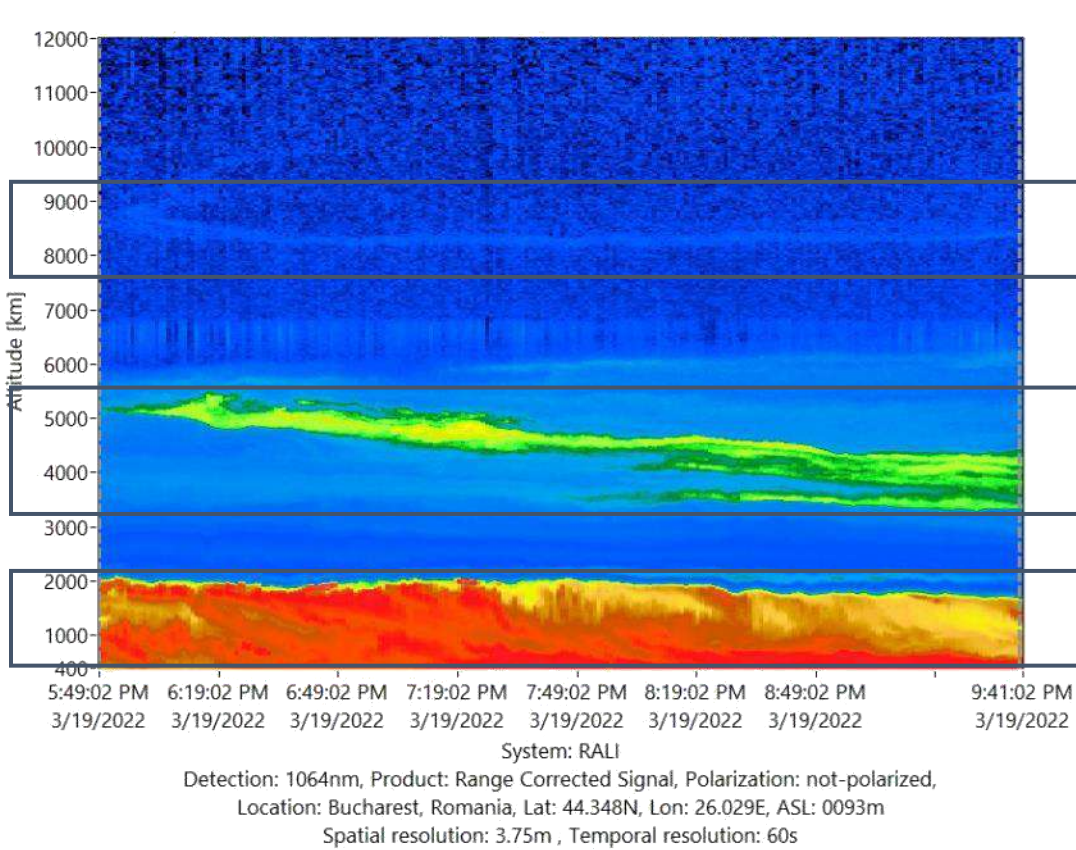
Aero\_trace, 21 March 2022 12:00 UTC, Ensemble of particles, N=40k



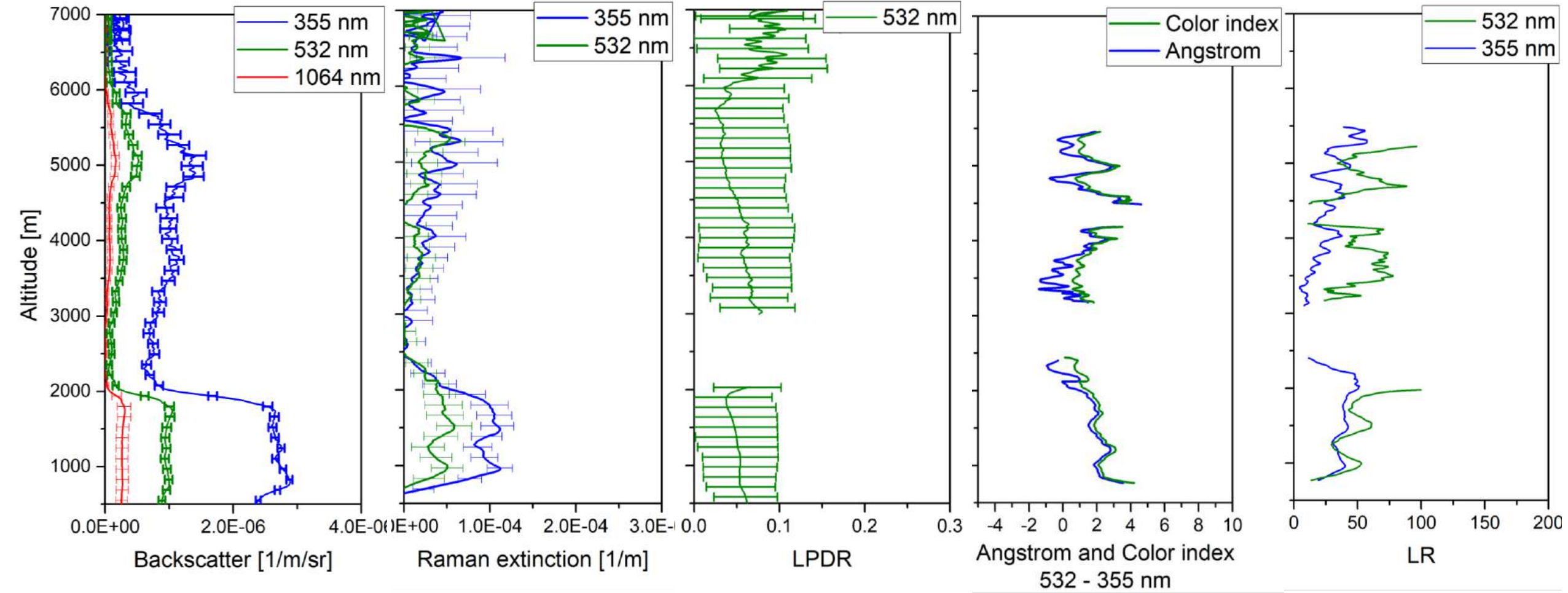
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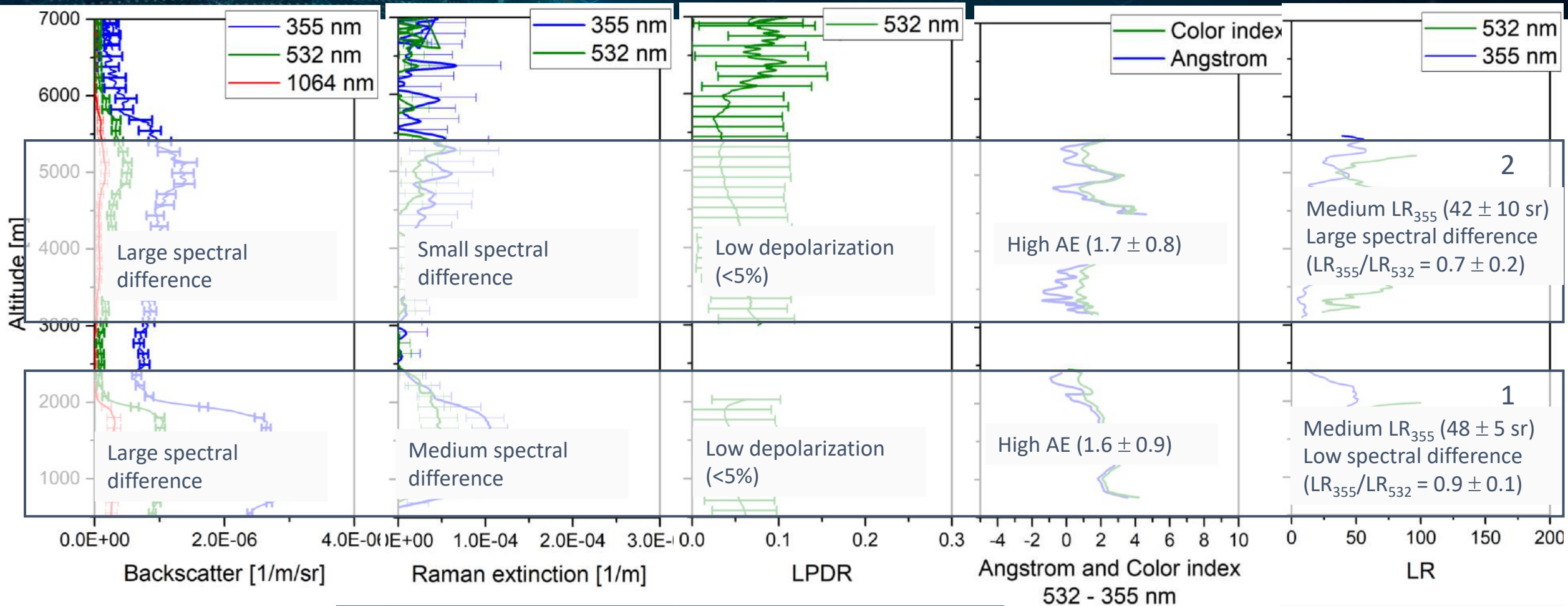
FLEXPART: ensemble of particles arriving @ MARS 11





# Detailed analysis of the aerosol



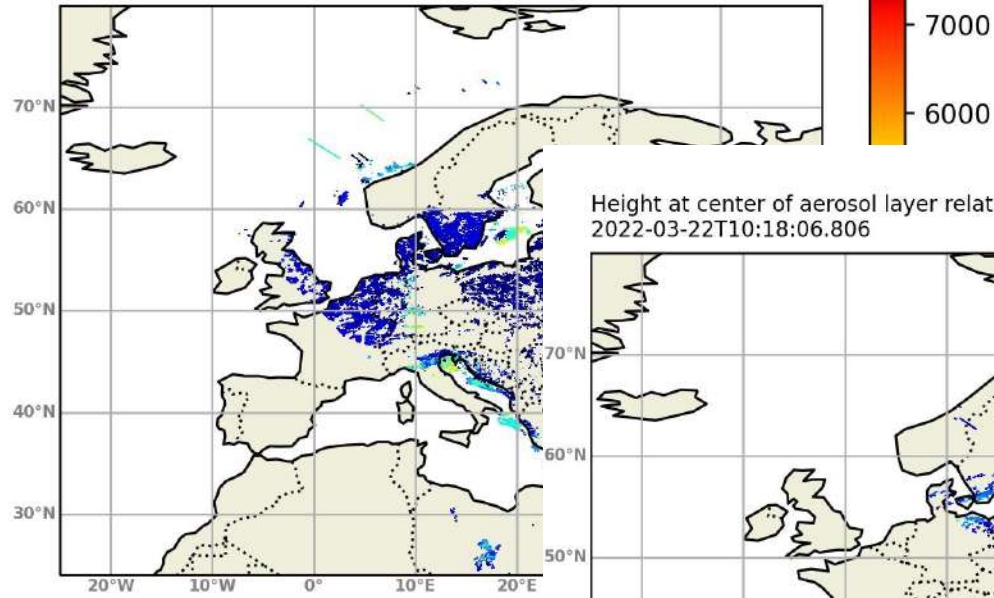


Aerosol typing: smoke mixed with continental

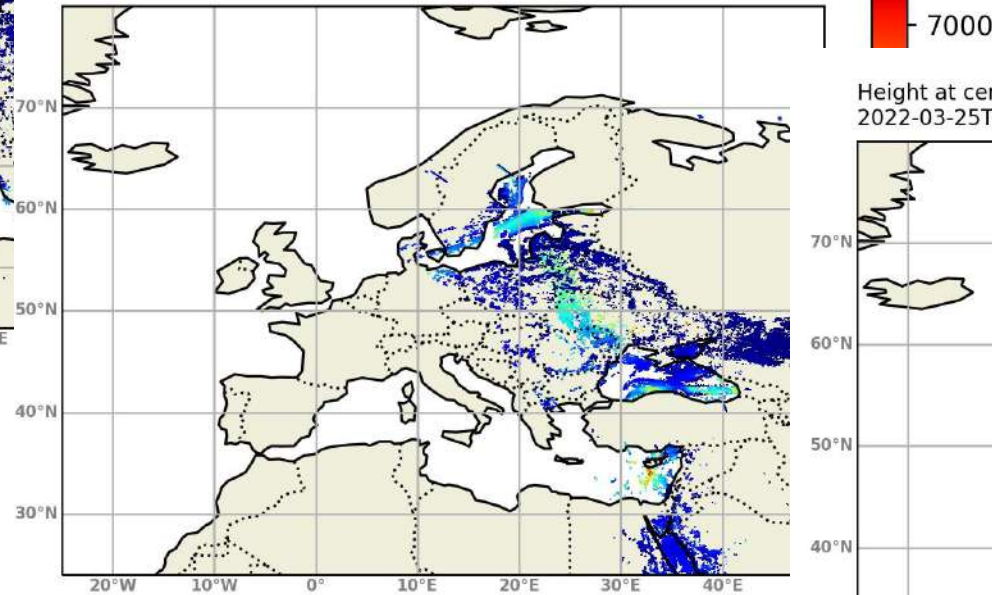
- Layer 1: local influence + long-range transported smoke
- Layer 2: long-range transported smoke + marine

# ALH S5P 19-25.03.2022 Europe

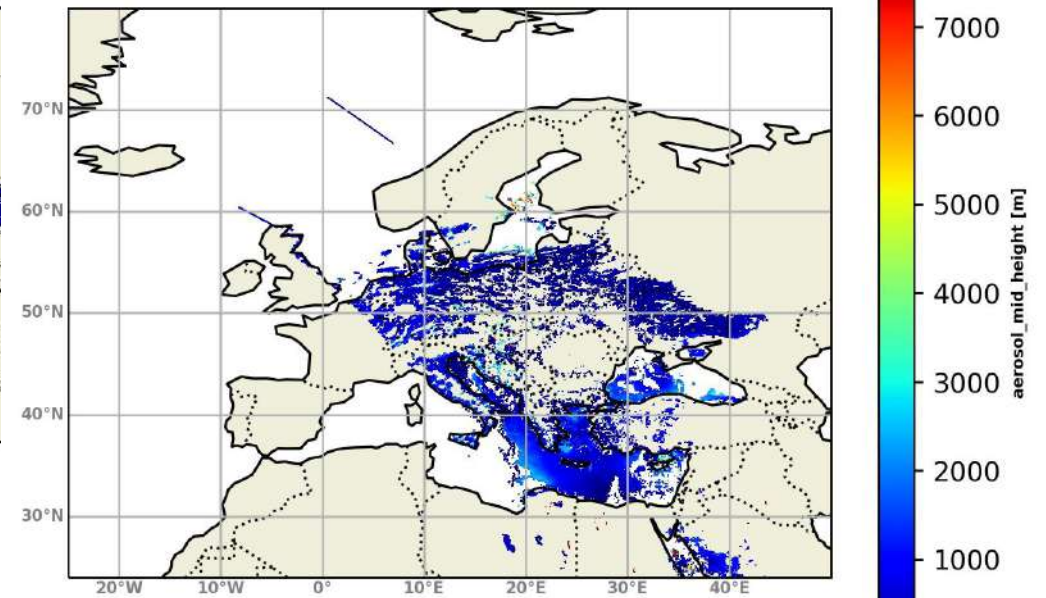
Height at center of aerosol layer relative to geoid  
2022-03-19T11:14:41.694



Height at center of aerosol layer relative to geoid  
2022-03-22T10:18:06.806

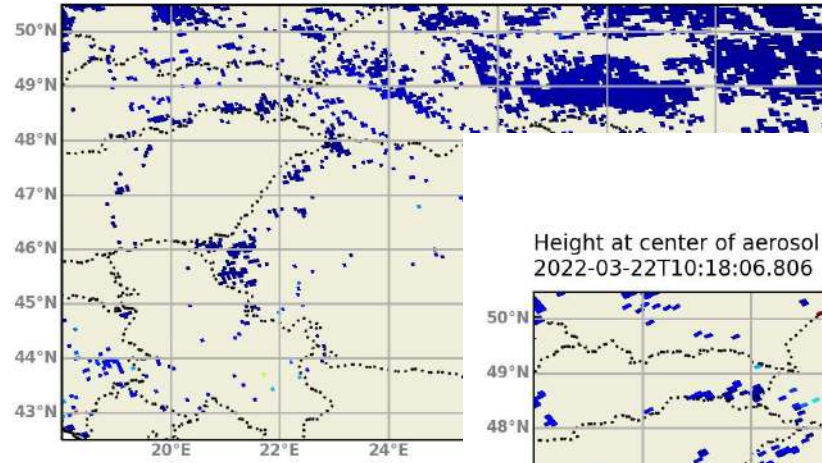
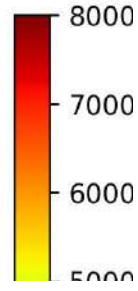


Height at center of aerosol layer relative to geoid  
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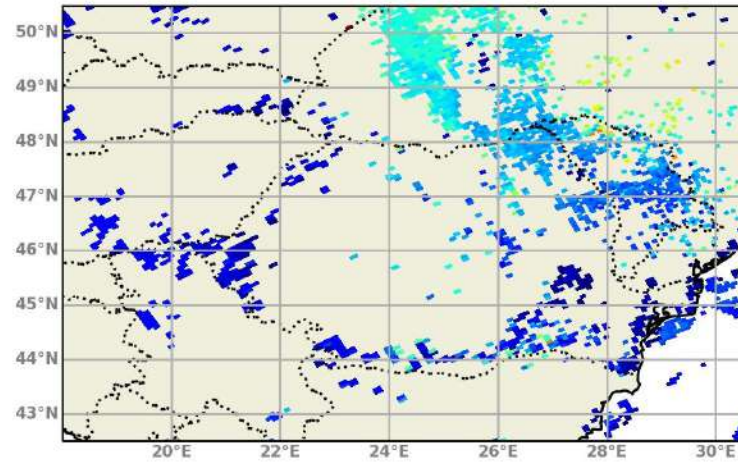


# ALH S5P 19-25.03.2022 Romania

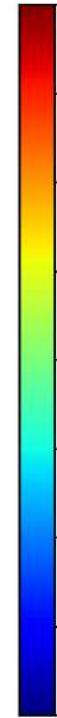
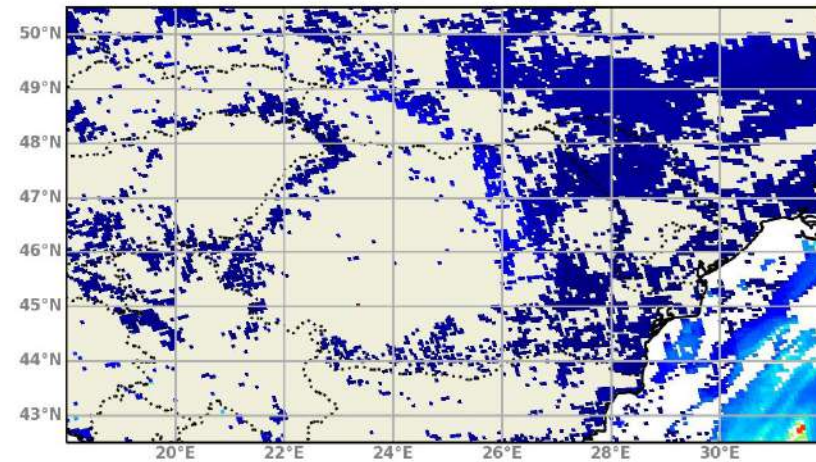
Height at center of aerosol layer relative to geoid  
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Height at center of aerosol layer relative to geoid  
2022-03-22T10:18:06.806



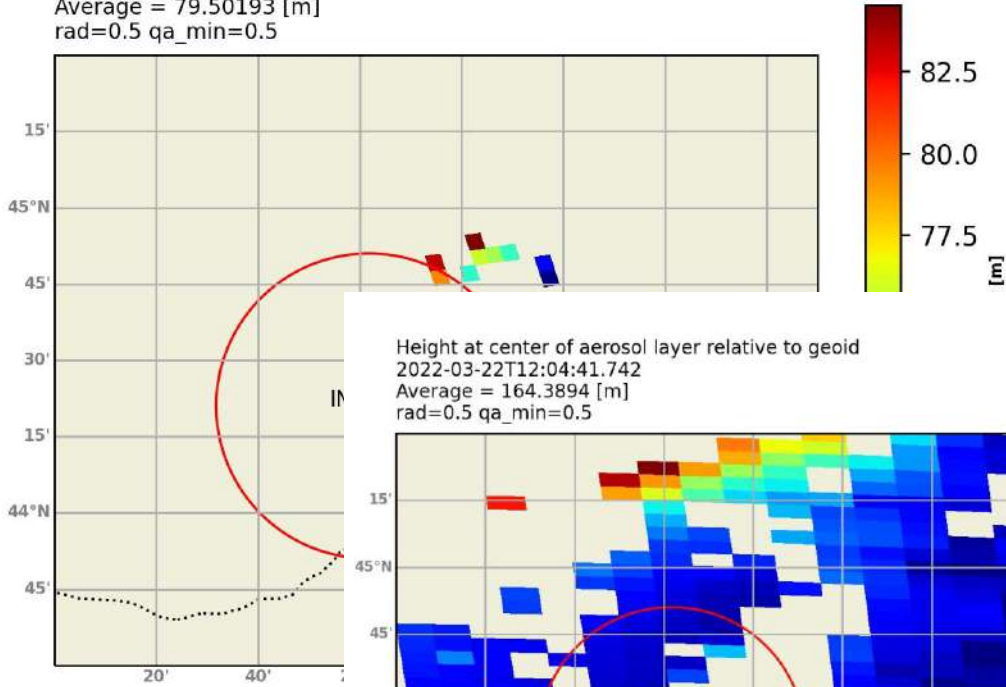
Height at center of aerosol layer relative to geoid  
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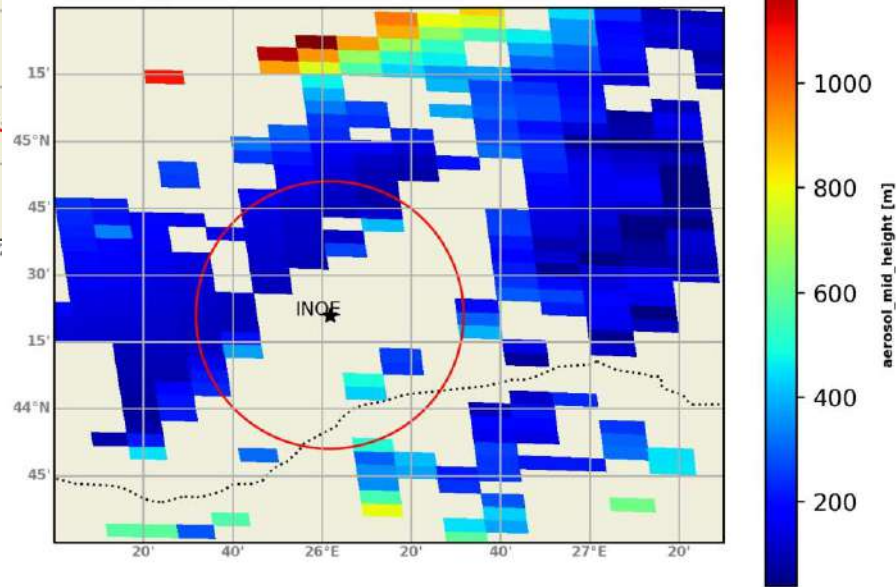


# ALH S5P 19-25.03.2022 Bucharest

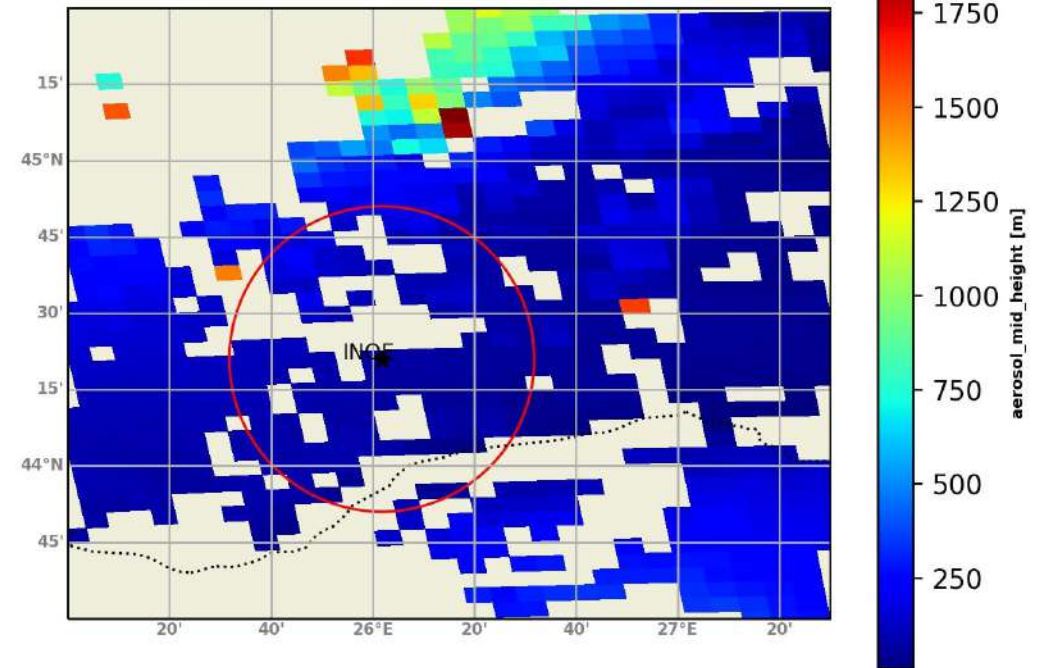
Height at center of aerosol layer relative to geoid  
2022-03-19T11:20:47.085  
Average = 79.50193 [m]  
rad=0.5 qa\_min=0.5



Height at center of aerosol layer relative to geoid  
2022-03-22T12:04:41.742  
Average = 164.3894 [m]  
rad=0.5 qa\_min=0.5




Height at center of aerosol layer relative to geoid  
2022-03-23T11:45:38.931  
Average = 91.074104 [m]  
rad=0.5 qa\_min=0.5




- 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 one representing the boundary layer” ATDB ALH TROPOMI


## 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!