

Service Tools for Aerosol Vertical Profiles

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Aerosol profiles: why interesting?

In situ observations provide a detailed insight on near surface particles concentration, dimension, optical properties, gases concentrations....

BUT

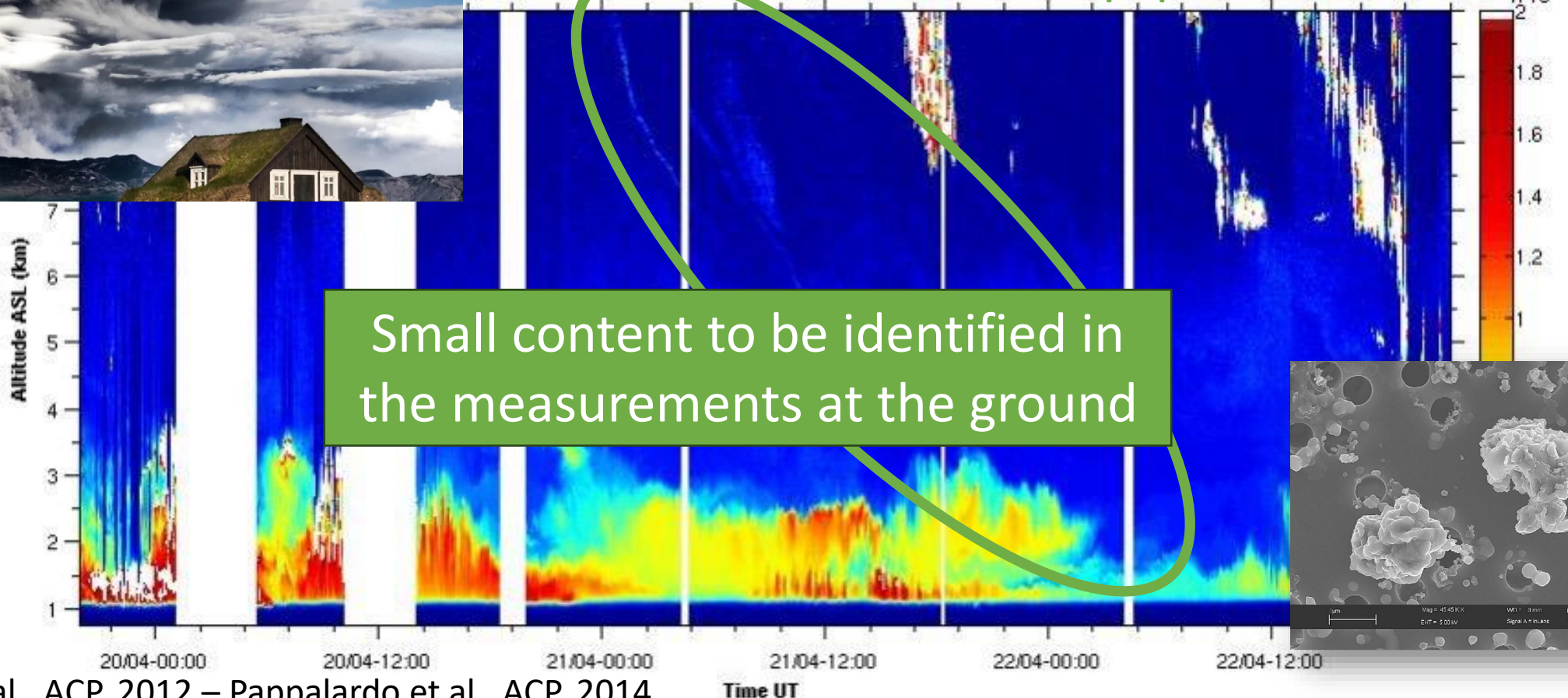
- atmosphere regions closeby in space (horiz+vert) and time in near surface conditions
- vertical dilution of locally emitted pollutants is essential
- BLH and properties in there are demonstrated to be fundamental in terms of Impact on health and ecosystems
- Different scales involved in dispersion process: mesoscale, local scale, microscale

Profiling observations can improve knowledge on these aspects

Long Range Transported Aerosol at ground

Identified on the base of optical properties as volcanic ash

Tito(Pz) MUSA Range Corrected Signal @ 1064 nm Analog
Start: 19/04/2010 19:50:43 - Stop: 22/04/2010 21:34:50

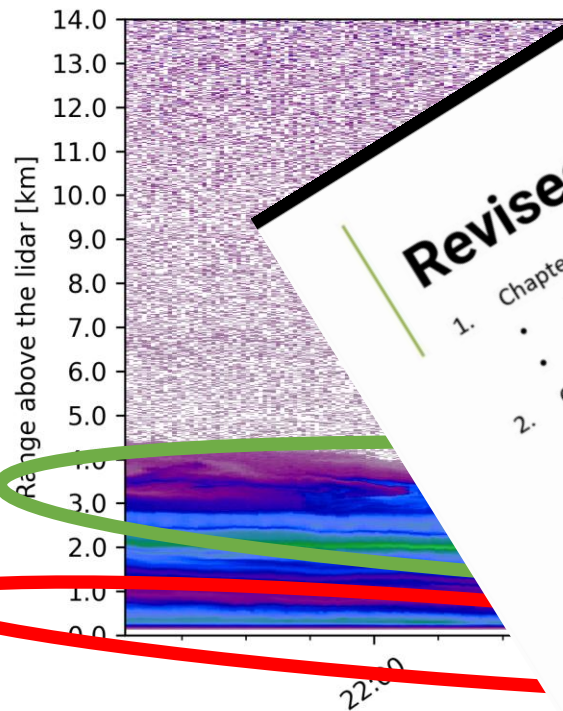


Mona et al., ACP, 2012 – Pappalardo et al., ACP, 2014

Long Range Transport at ground

Depolarization as clear trace

Fixed_Lidar_Raymetrics_L1
On 19.05.2024 from 22:00



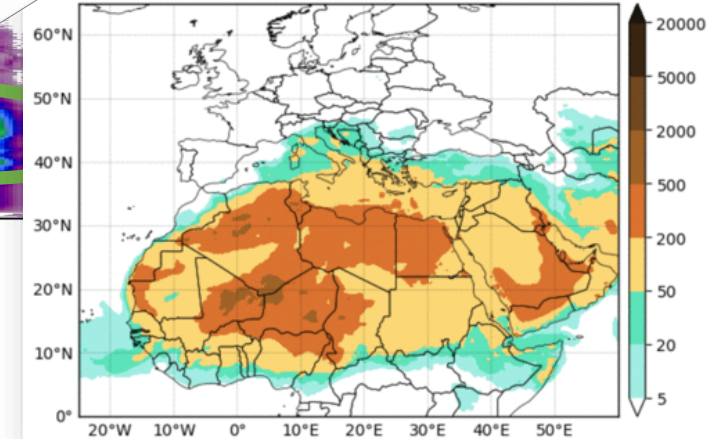
Revised AAQ Directive

- Chapter I General provisions (art1-6) + Annex I
 - New limit and target values to be attained by 2030
 - Regular revision
- Chapter II Air quality assessment (art 7-11)
 - UFP
 - Supersites: Art 10 + Annex VII
 - Reference methods + DQO: Art 11 + Annex VI + Annex V
- Chapter III AQ management
 - Contribution of natural sources and winter sanding and salting
 - Postponement
- Chapter IV Plans + Annex VIII
 - AQ roadmaps
 - AQ plans
 - Short-term actions plans

- Chapter V: information and reporting (art 22-23)
- Chapter VI: delegated implementing acts (art 24-26)
- Chapter VII: Access to justice, compensation and penalties. (art 27-29)
- Chapter VIII: Transitional and final provisions (art 30-32)

European Environment Agency
RI-URBANS

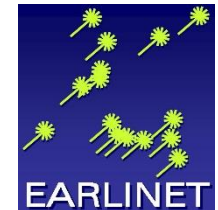
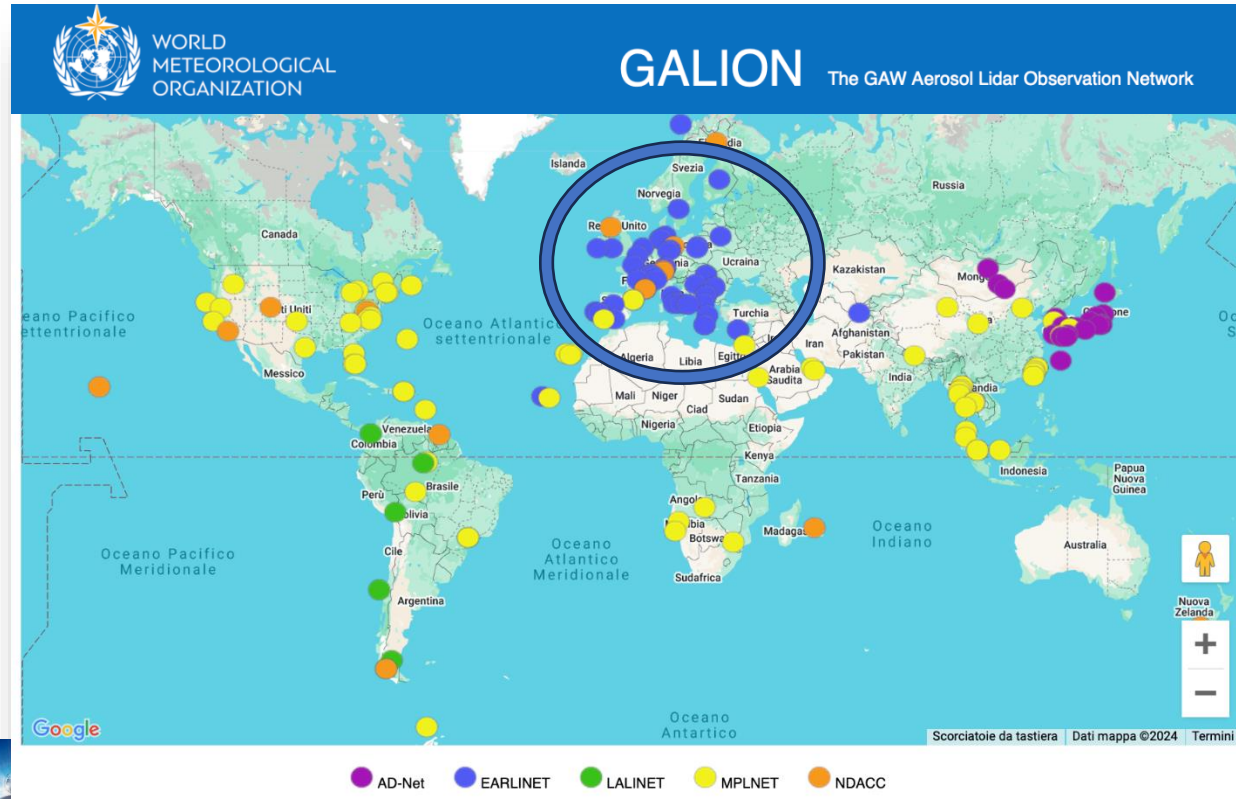
WMO SDS-WAS N.Africa-Middle East-Europe RC
MEDIAN Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12h 19 MAY 2024 Valid: 12h 19 MAY 2024 (H+00)



RI-URBANS (101036245)
4th Science meeting, Barcelona, 8-9 September 2025

Where are we with observations?

- Optical properties profiles are provided by **Aerosol Lidars** (different techniques- elastic, micropulse, Raman, HSRL)



Where are we with observations?

- Ceilometers -> much more dense coverage

Promising in revealing aerosol structure but mostly without QC for aerosol optical profiles



**NOT YET
consolidated
QA/QC**

Ceilometer-based Experimental Service Tools for aerosol profiling

Automated Lidar Ceilometers (ALC) allow near-real time, continuous (24/7) aerosol monitoring

Within RI-URBANS: Development and validation of ALC-Based Products through original Algorithms

Bellini et al., AMT, 2024;
Bellini et al., Rem. Sens, 2025

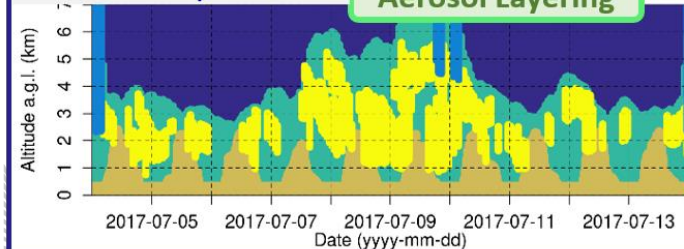
Focussing on those targeted to Air Quality

ALICEnet
Automated Lidar-Ceilometer network

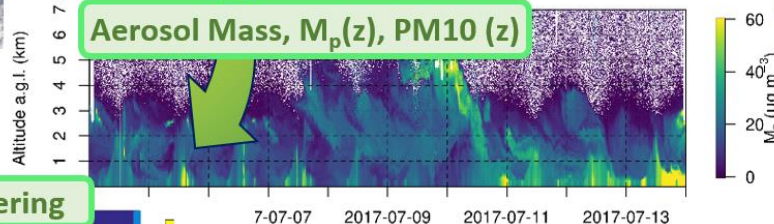
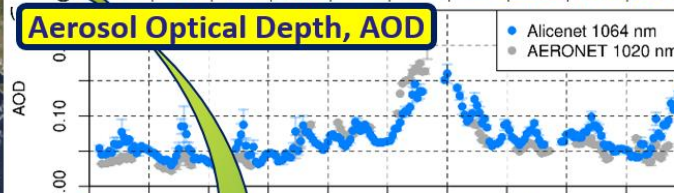
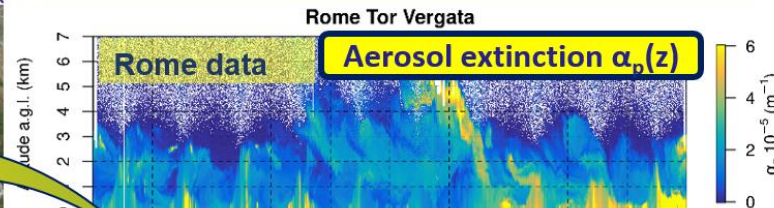


EAL = Elevated Aerosol Layer
MAL = Mixed Aerosol Layer
CAL = Continuous Aerosol Layer
CLOUD = Cloud
MOL = Molecular/No aerosol

Aerosol Layering



Examples of ALC-based Products



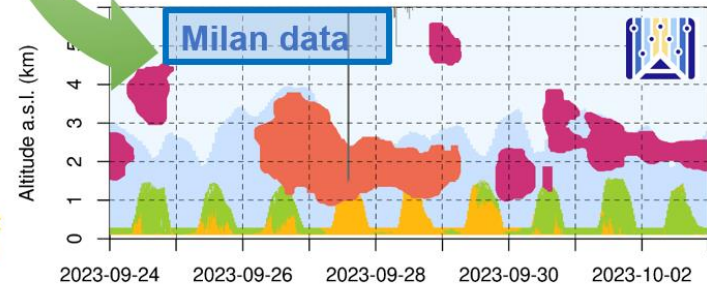
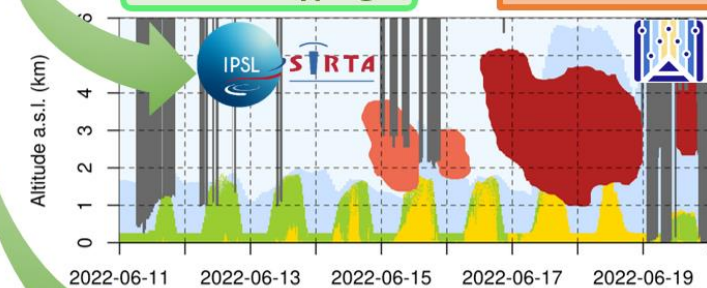
Clouds
Aerosol free -Molecular
Regional Background Aerosol
Mixed continental
Local resuspension / Entrained Desert Dust
Transported Continental Aerosol or Smoke
Transported & Processed Desert Dust
Transported Desert Dust

RI-URBANS



Aerosol Typing

Paris data



Paper in preparation, 2025



Commission I



Aerosol High power lidars

- Thanks to ACTRIS high level of standardization at instruments side and data through SOPs, QA and QC procedures
- Tools are available as service from ACTRIS RI about aerosol profiles – CARS (Topical Centre) and ARES (Data Centre) the core of such systems



ST Aerosol Optical properties

- **Fully Quality Assured/Quality checked**
- Centralized processing and provision
- **Open and FAIR data**
- NRT provision
- Human interface + machine to machine access
- PID and annual DOI provided



All these «services» offered to noACTRIS sites as DC services



ATMO ACCESS
Access to Atmospheric Research Facilities

ST Aerosol climatological products

33 sites -2000-2019



- **Fully QA/QC data**
- Criteria for file selection
- Source data filtering



- **Open and FAIR data**
- Centralized processing
- DOI assignment

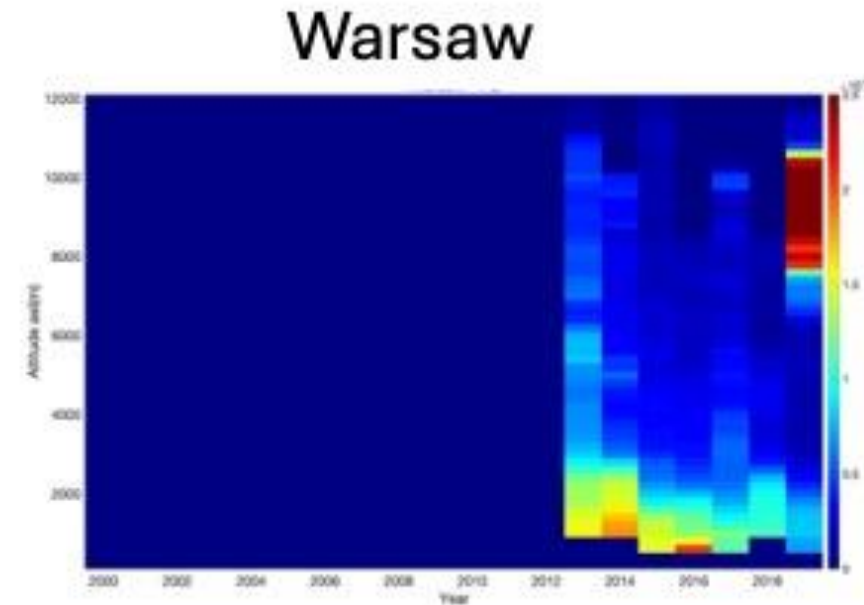
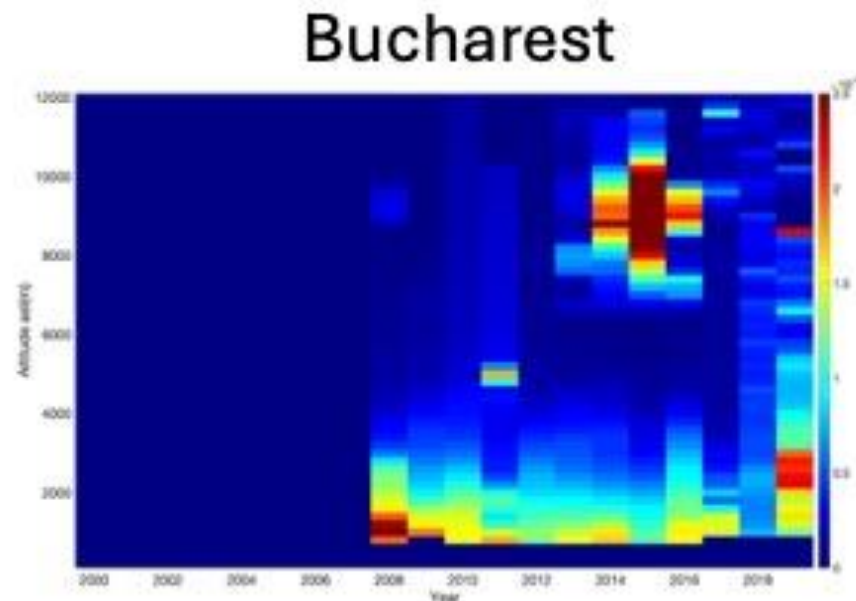
<https://github.com/actris-ares/actris-level3-aerosol-profiling-climatology>

https://commons.datacite.org/doi.org/10.57837/cnr-ima/ares/actris-earlinet/level3/climatological/2000_2019/all

ST Climatological products

33 sites -2000-2019

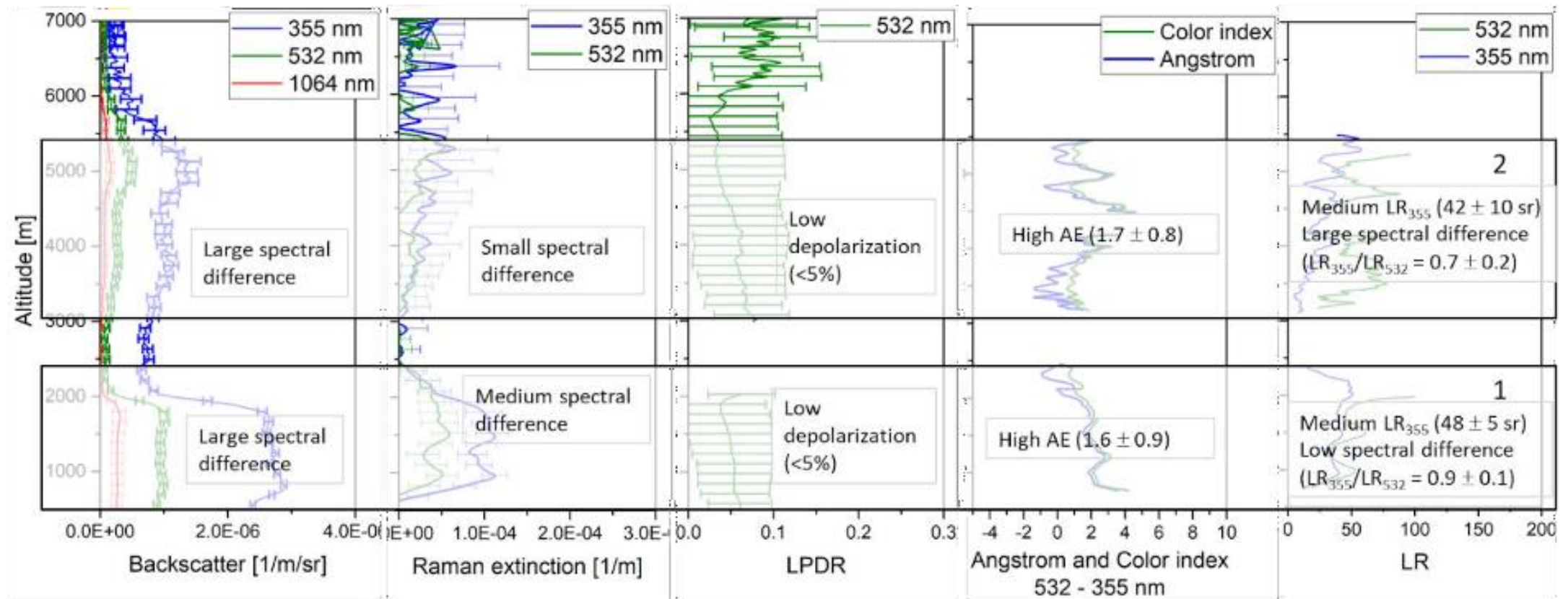
Annual averages of aerosol backscatter profile at 532 nm



Slightly decreasing trend in the altitude of the transient between aerosol presence and aerosol free zone in the atmospheric column and a shift of the colors from warm to mid intensity colors.

Aerosol typing from multiwavelength Raman/HSRL

Advanced lidars can provide much more than simply structures
identification: **quantitative values + typing!**



ST – Aerosol typing

26 sites -2015-2023



- Fully QA/QC data
- Criteria for file selection
- Source data filtering

Experimental
dataset
provided
within
RIURBANS



- Centralized processing
<https://natali.inoe.ro/resources.html#software>
- DOI assignment

To be assigned by ACTRIS ARES through



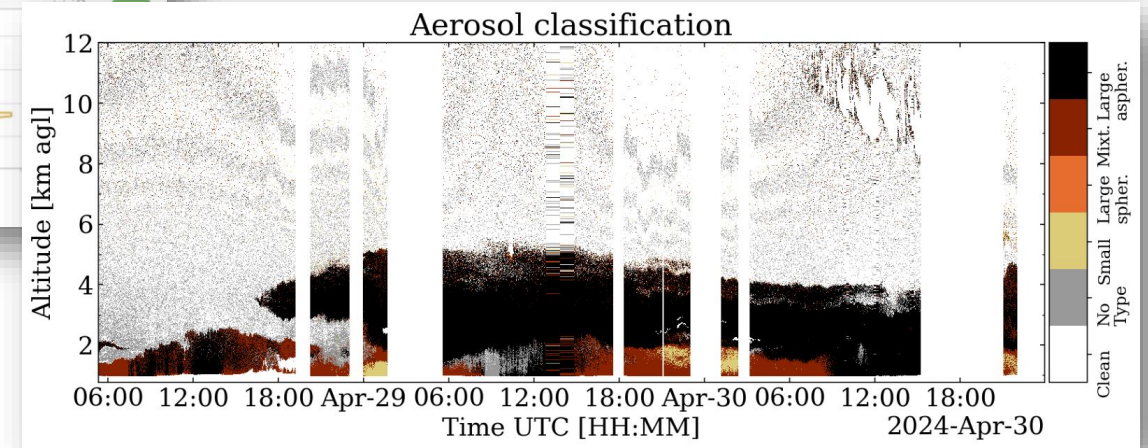
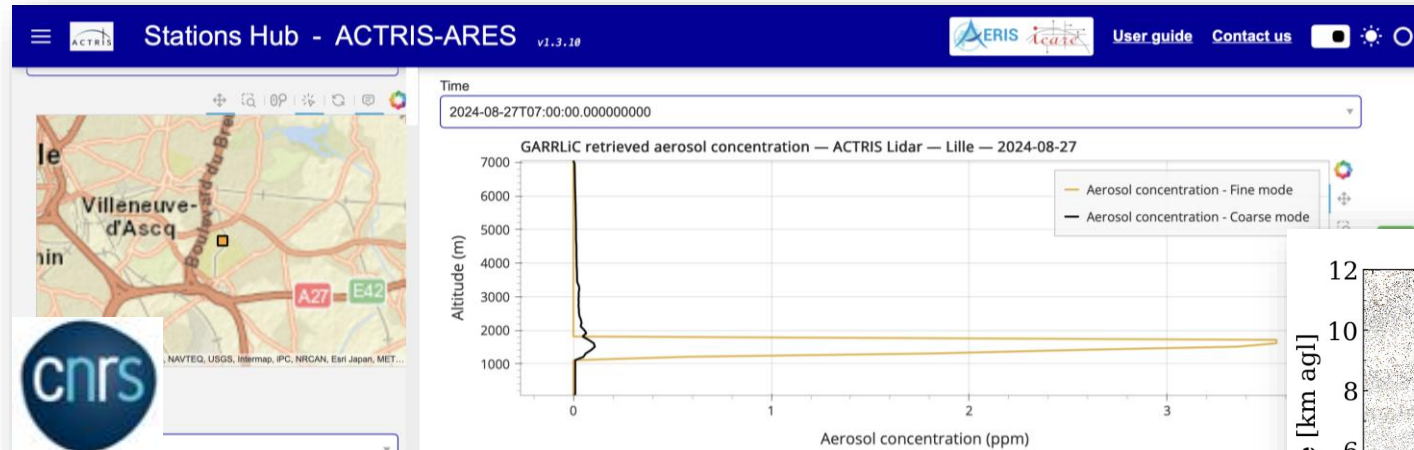
Conclusions

- Providing service tools as services (from NRT to climatological data)
- First investigations carried out -> papers in progress
- Digital tools made available
- Further data can still be added through



Progresses after ST publication

- Operational Provision of ***Profiles of volume fine and coarse concentration***
- Operational Provision of ***Profiles of High Resolution Aerosol Classification***



Progresses after ST publication



- Ongoing implementation of ***Profiles of Low Resolution Aerosol Classification***
- Update of the Aerosol ***Profiles Climatology to 2000-2021***

Long term plans

- QA/QC for aerosol profiles from ceilometers within ACTRIS

Thank you!