ACTRIS Aerosol Remote Sensing data center: ARES overview

Lucia Mona – lucia.mona@cnr.it

https://orcid.org/0000-0003-4157-0838

Consiglio Nazionale delle Ricerche – IMAA https://ror.org/024ye7w89

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Ministero dell'Università e della Ricerca

Italiadomani

Agenda

- ACTRIS – ARES : a flavor of it
- ARES Unit: data and workflow
- Use cases

Main responsibilities of ARES

(meta)data curation, data processing, data quality controls and
(meta)data provision of Aerosol Remote Sensing observations

Aerosol Remote Sensing National Facilities

Provision of Data

CARS Central Facility

QA test results

ACTRIS – ARES Unit

Services provided:

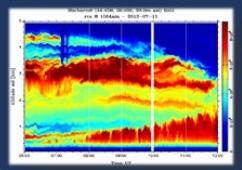
- Unique access point for aerosol remote sensing (meta)data and data products
- Tools for data upload, visualization and handling
- Quality Assurance / Quality Check
- Long term sustainable archive
- Data Versioning
- Central data processing (SCC)
- Training / Support
- Traceability
- Reprocessing
- Links with DC Units, TCs, NFs
- Link with international bodies for use of ARES data and services

Level 0 data

Raw Data

Level 1 data

High/Low Resolution Total Attenuated Backscatter and Volume Depolarization Ratio time series

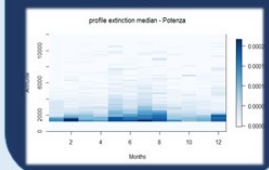


Level 2 data

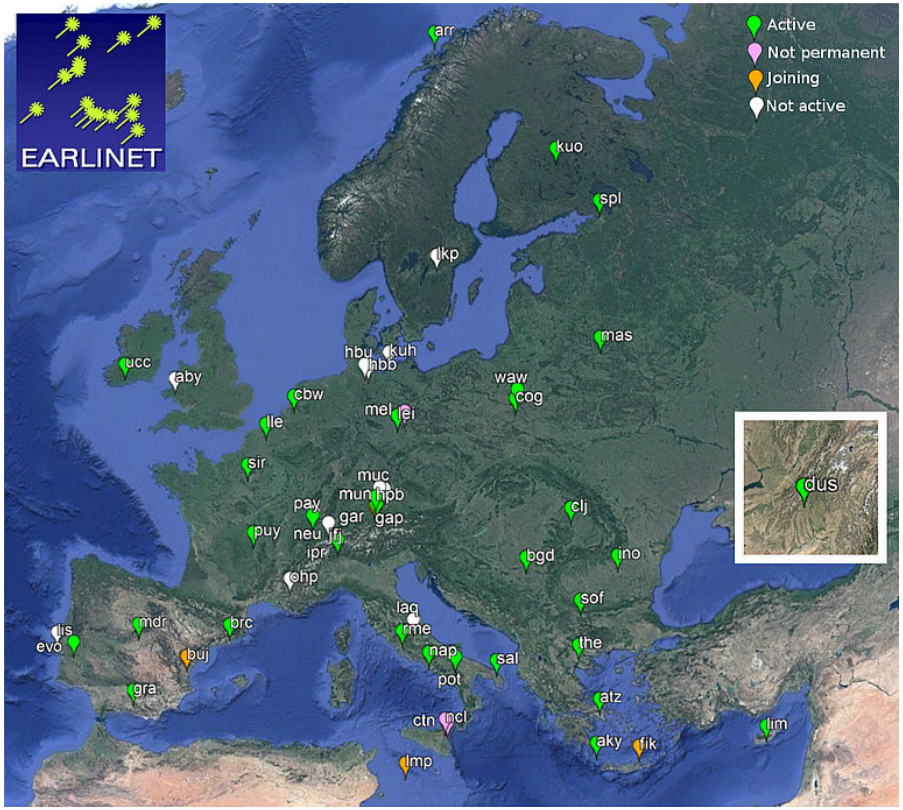
Fully Quality Assured Aerosol optical and microphysical vertical profiles

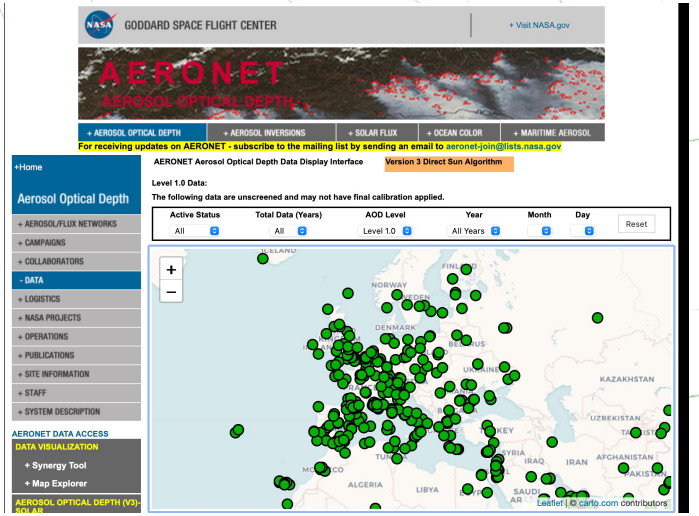
Level 3 data

Statistical Analysis (e.g. seasonality, annuality) of Aerosol Optical Parameters



Scientific community





ARES concept

To assure **standardization**, **traceability** and **reprocessing** capability

Database and services re-design:

- Versioning
- PIDs/DOIs and provenance
- CF 1.7 compliance (new data format and names)
- On-fly QC documented procedures on data
- Interoperability and automation

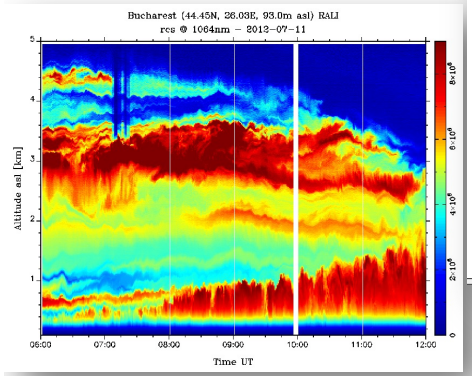
Centralized automatic processing software:

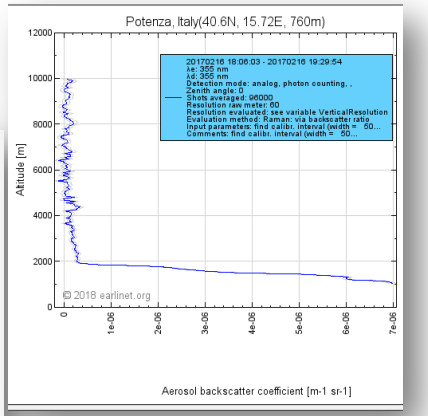
- Single Calculus Chain (SCC)

ARES data

- Raw data at native vertical and temporal resolution
- Pre-processed lidar data (low and high temporal resolution)
- Cloud masking
- Optical properties, multi-wavelength and high-resolution profiles
- QC optical properties
- Climatological products
- Tailored products (like Eyja)

ARES Data Level Structure





Pre-processed signals

High Resolution products

High quality profiles

Multi-wavelength

Layering /Typing products

EARLINET-AERONET combined data

ACTRIS data level 0

Raw sensor output. Native resolution, metadata necessary for next level

Established format and content

ACTRIS data level 1

Calibrated and quality assured data with minimum level of quality control.

Potential NRT release

ACTRIS data level 2

Approved and fully quality controlled ACTRIS data product or geophysical variable

Potential NRT release

QC procedures

ACTRIS data Level 3

Elaborated ACTRIS data products derived by post-processing of ACTRIS Level 0 -1 -2, and data from other sources. The data can be gridded or not.

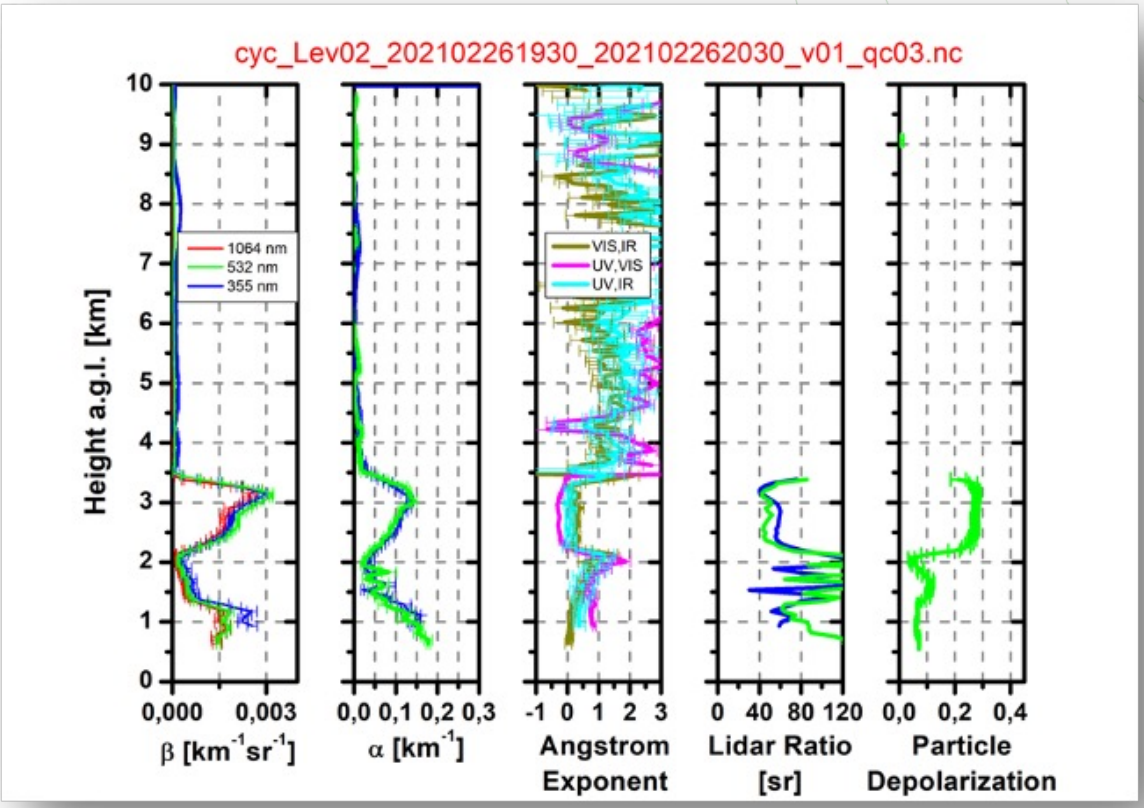
Level 3 climatogical

Synthesis products

Data products not under direct ACTRIS responsibility from e.g. research activities, citizen science, for which ACTRIS offers repository and access.

Aerosol optical profile products

- Final products of SCC *(D'Amico presentation)*



Multi-wavelength products

Currently data file are single product oriented (1 backscatter or 1 extinction , single wavelength)

Multiwavelength product with all available aerosol optical property profiles at the same vertical-temporal resolution currently **available in experimental mode**

Multiwavelength product will allow for more robust aerosol layering and typing products

More about this in the afternoon

Level 3 climatological dataset

Covered period: 2000-2019

Based on L2 (QC v03) available in Oct 2022

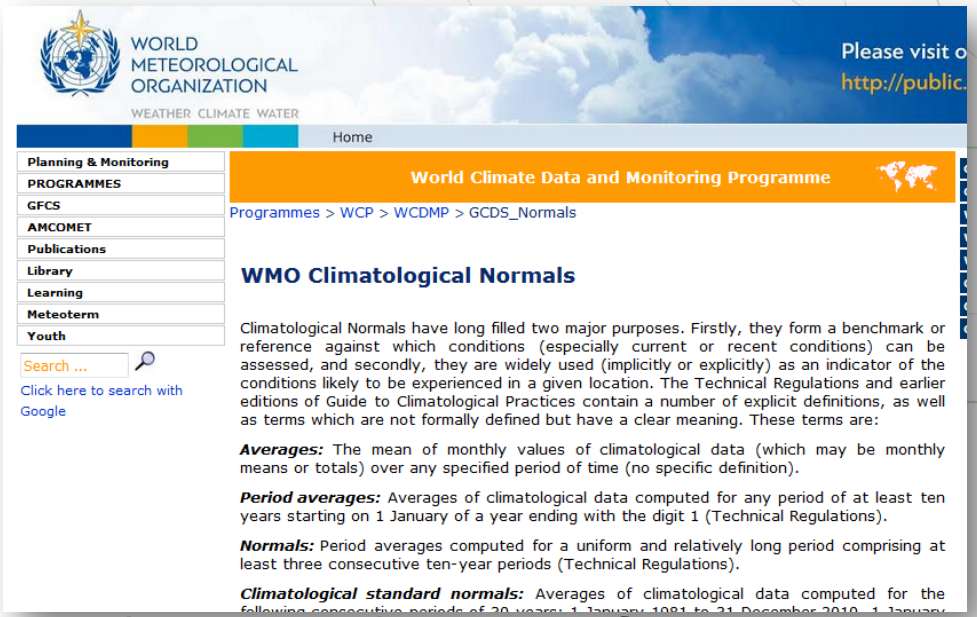
33 stations included in the dataset

Station Code	Name	Station Code	Name	Station Code	Name
aby	Aberystwyth	hpb	Hohenpeissenberg	nap	Naples
arr	Andøya	ino	Bucharest	pot	Potenza
atz	Athens	ipr	Ispra	puy	Clermont-Ferrand
brc	Barcelona	kuh	Kuehlungsborn	rme	Roma-Tor Vergata
cbw	Cabauw	lei	Leipzig	sal	Lecce
cog	Belsk	lkp	Linkoping	sir	Palaiseau
dus	Dushanbe	lle	Lille	sof	Sofia
evo	Evora	mas	Minsk	spl	St. Petersburg
gar	Garmisch	mdr	Madrid	the	Thessaloniki
gra	Granada	mel	Melpitz	ucc	Cork
hbu	Hamburg	muc	Maisach	waw	Warsaw

The aggregates and L3 data types

Climatological Normal

Period averages computed for a uniform and relatively long period comprising at least three consecutive ten-year periods.

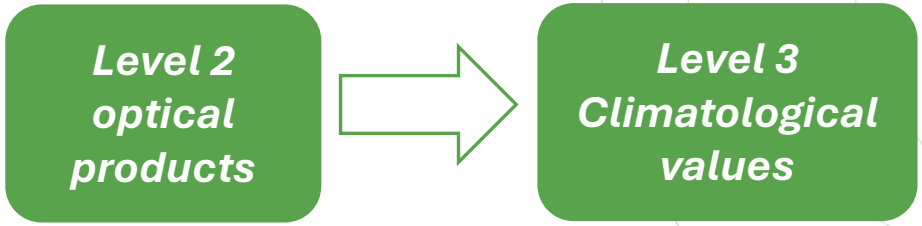


What Normal in our case?

NormalSeason is:

Average over years (e.g. 2000-2019) for each Season: the mean of Spring 2000, Spring 2001,…Spring 2019 is the Spring normal average

Some issues – sampling and weights



- EARLINET measurements are not h24
- Not daily performed
- Potential biases to be avoided in the aggregation
- Sampling could be not uniform over months and season

Some issues – sampling and weights

- Only climatological (defined schedule) and satellite overpasses measurements are considered
- Data flagged as with cirrus presence were disregarded
- Additional checks performed on the data prior the temporal aggregation on some parameters
- Appropriate weights introduced for avoiding unbalance between more populated and less populated periods in longer temporal aggregations

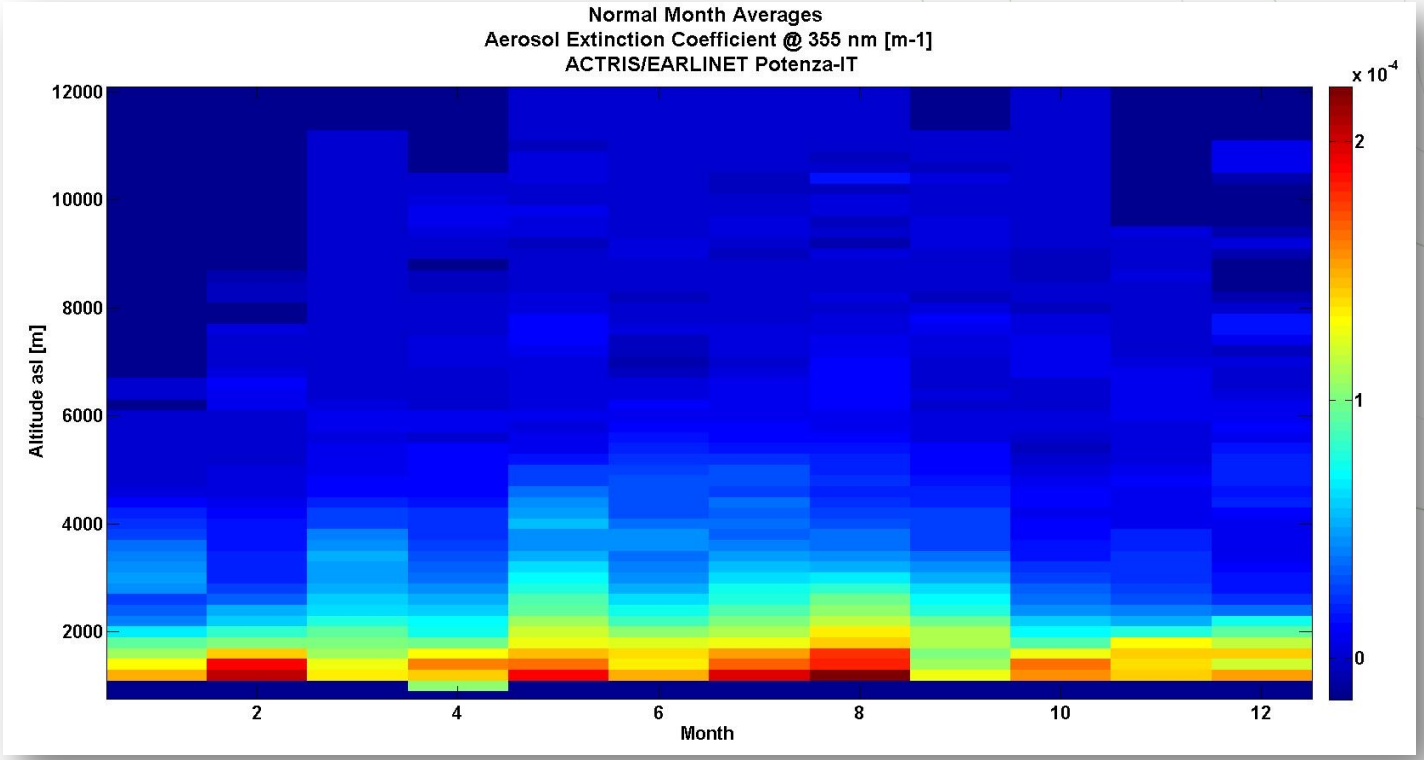
Some issues – sampling and weights

- All profiles are reported on the same vertical scale from 100 up to 12100 meters.
- Data are just divided in 60 layers, each one 200 meters wide. The bounds of layers are at fixed altitudes: 100 – 300 m, 300 – 500 m,etc

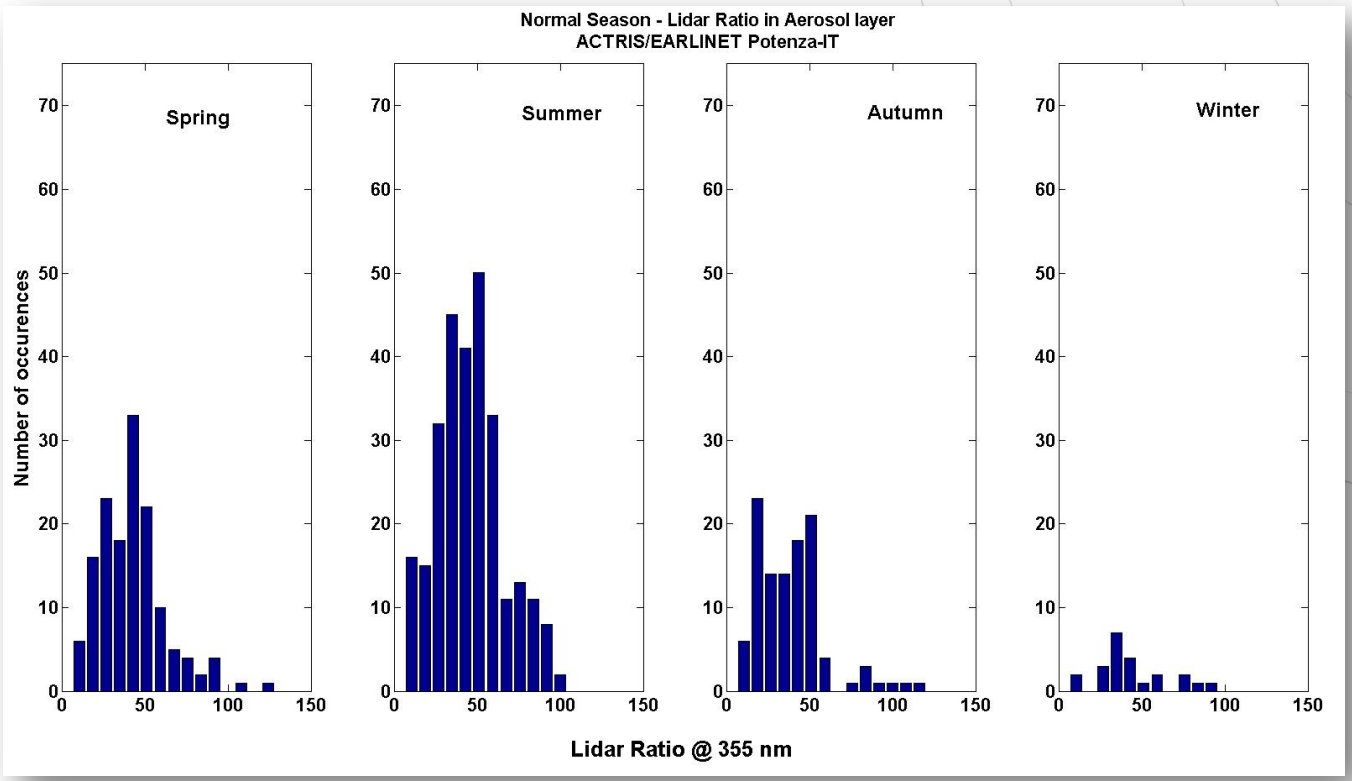
Examples showed for **Potenza**:

- ❑ one of the highest number of data collected within the network
- ❑ affected by dust, volcanic, fires….

Level 3: some examples (1/2)

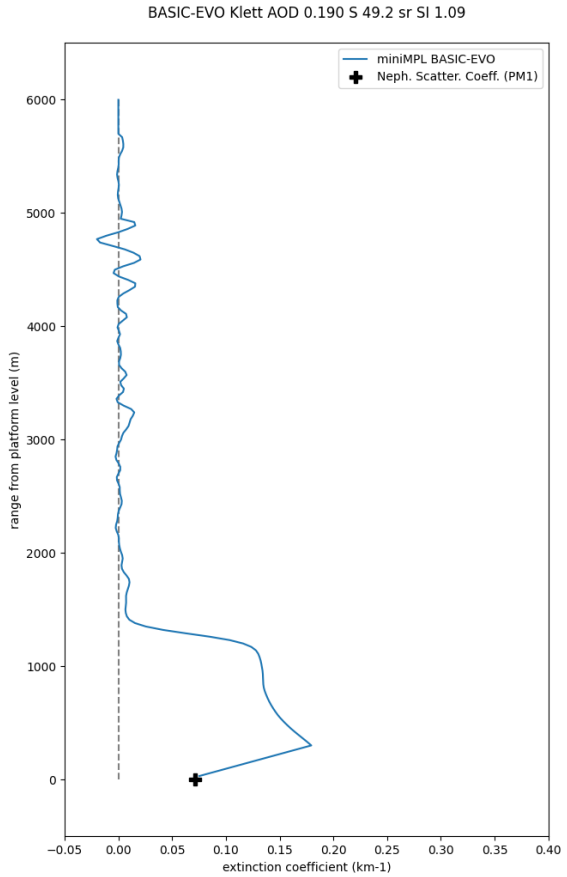


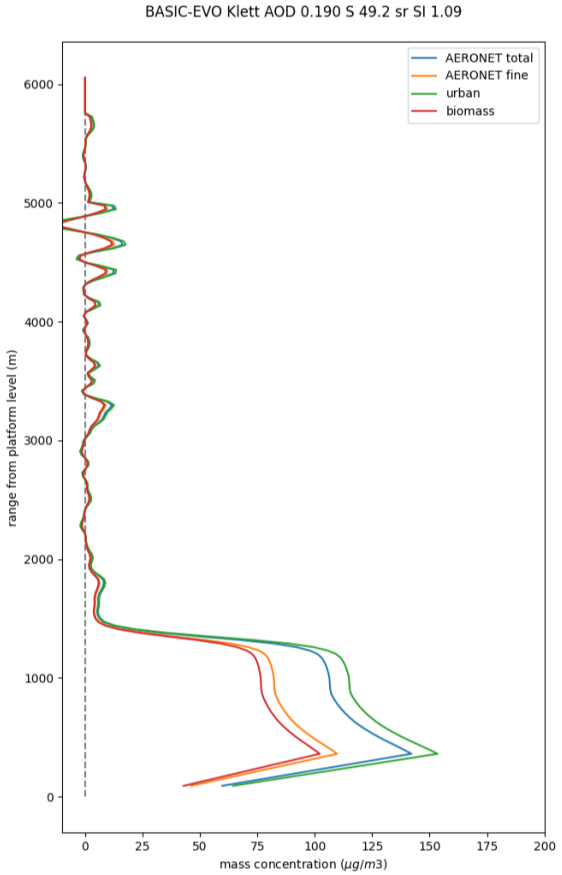
Level 3: some examples (2/2)

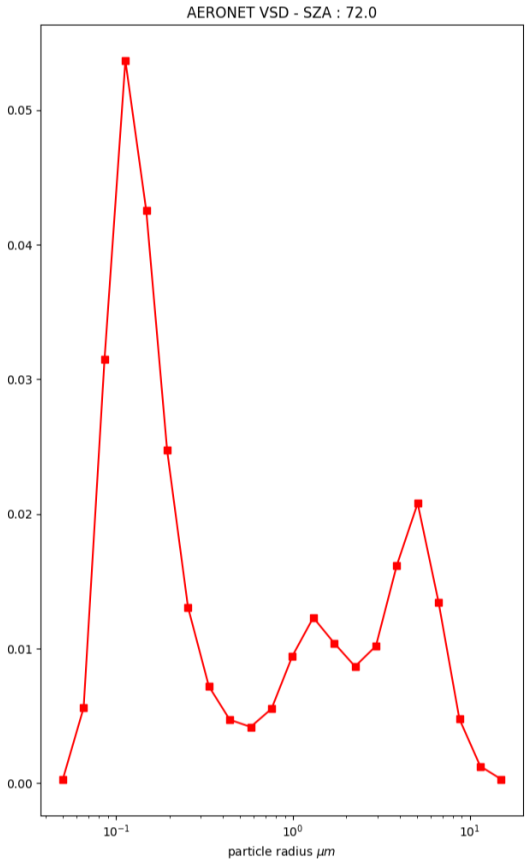


Lidar + Photometer retrieval

Mini MPL MF Lille – 2018-05-14 16h37







QA and QC– Basic Definition

QA

Quality assurance

Actions aiming to improve the quality of measurements before they are taken.

Mainly on the systems

Mainly in the hands of CARS

vs

QC

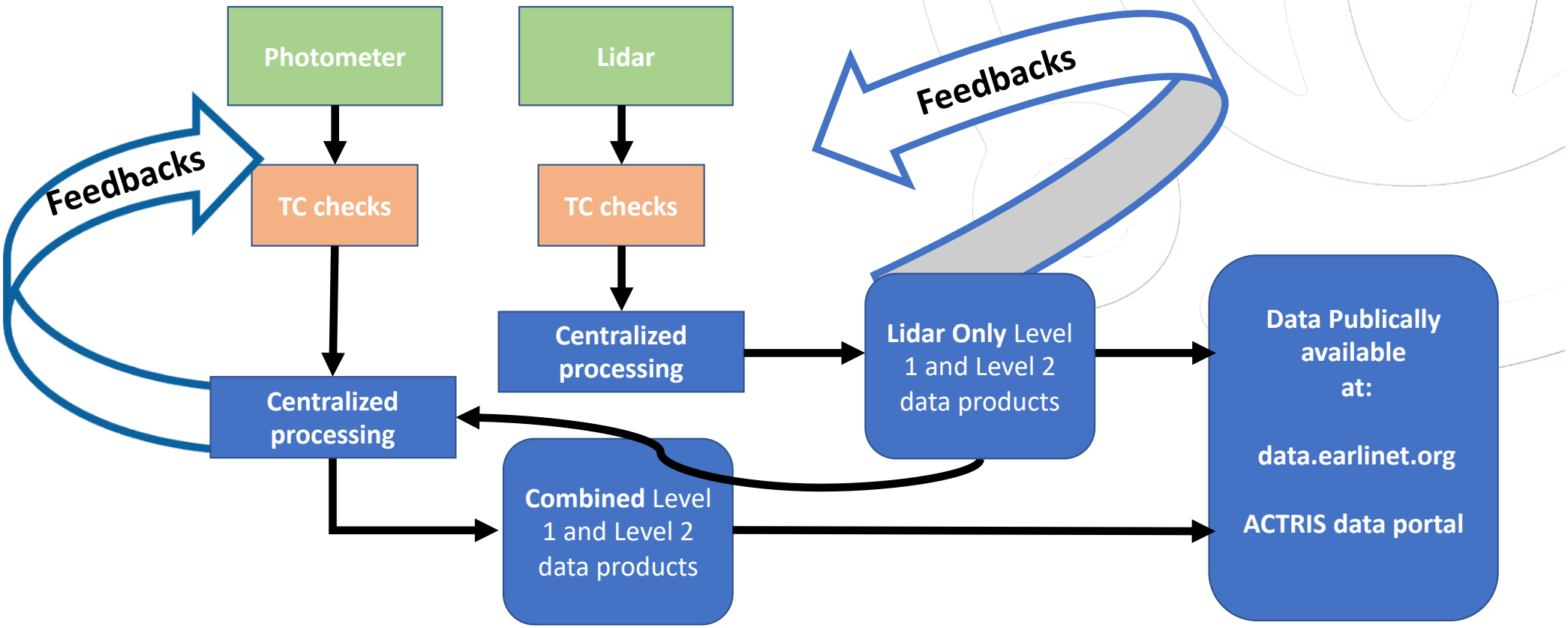
Quality control

Actions for checking the quality after the measurements are taken.

Mainly on data

Mainly in the hands of ARES

Aerosol Remote Sensing Workflow



CARS – ARES and stations Responsibilities

Data are freely and openly available to all.
Data property remains with PIs and stations.

Responsibility on data remains on PI shoulders

CARS and **ARES** support **PIs** in assuring and checking the quality of measurements and data.

Parameters to be checked by CARS and ARES

Operational vs Experimental Configurations

- SCC highly flexible → essential for the variety of instruments available in the network

  precious for allowing standardized data but also for different set up useful for specific studies

Operational configuration: standard routinely data → can access the Level 2 data label

Experimental configuration: cannot become Level 2 data

From RAW data to Level 2 data

Level 2 data are fully quality controlled data if all these are valid at the same time

- Data acquired with fully CARS QA lidar system
- Data acquired following all Standard Operating Procedures
- Data obtained using the standardized processing system (SCC)
- Data obtained using the Operational configuration in SCC for that system at that time (linked to CARS QA)
- Data compliant with all automatic quality control procedures implemented at ARES

From Station to ACTRIS database

Check of raw data at the station

SCC
Single Calculus Chain

Check of output data at the station

Database

Delayed Provision

* <72 h from taking measurements

From Station to ACTRIS database

Automatic submission tool

SCC Single Calculus Chain

Automatic upload option enabled

Database

NRT* Provision

Check of raw data at the station

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Level 2 data

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Delayed Provision

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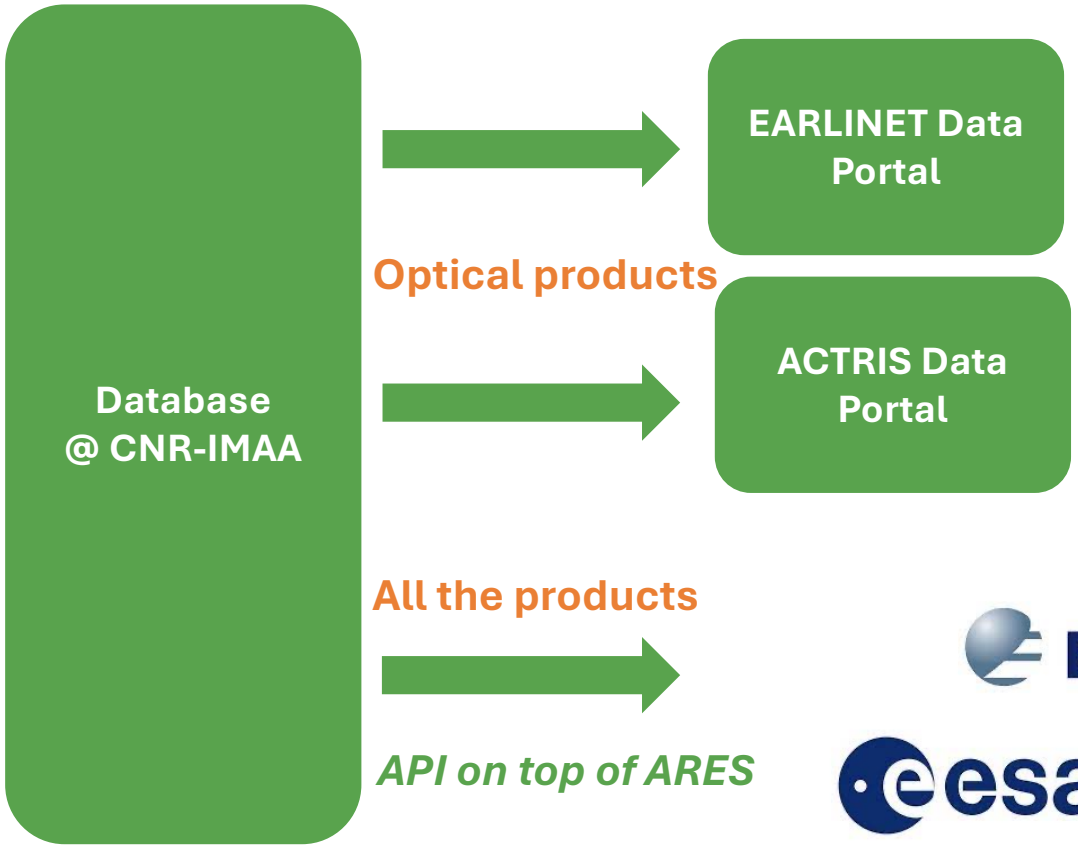
From the database to externals – Current status



API working on the whole ACTRIS DC

From the database to externals

Database @ CNR-IMAA

PID and DOI are associated to each data on the database for full traceability

PID for small granularity

DOI for conspicuous datasets and QC data

DOI (Digital Object Identifier)

- A DOI name is a digital identifier of an object, any object — physical, digital, or abstract. DOIs solve a common problem: keeping track of things. Things can be matter, material, content, or activities.

- Designed to be used by humans as well as machines, DOIs identify objects persistently. They allow things to be uniquely identified and accessed reliably. You know what you have, where it is, and others can track it too.

ARES DOI

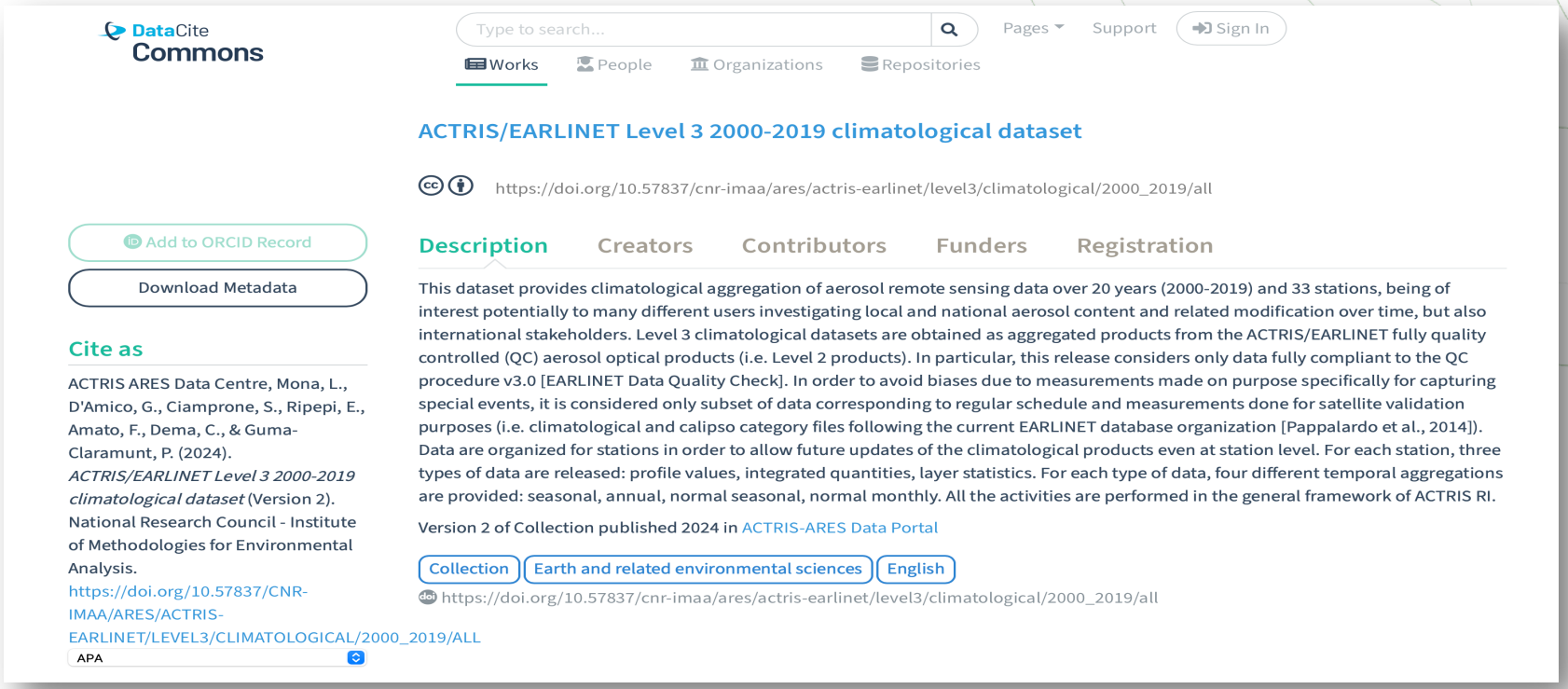
- ARES provides DOI through CNR IMAA joined Italian DataCite Consortium

- **DataCite** is a global community that shares a common interest: to ensure that research outputs and resources are openly available and connected so that their reuse can advance knowledge across and between disciplines, now and in the future.

https://datacite.org

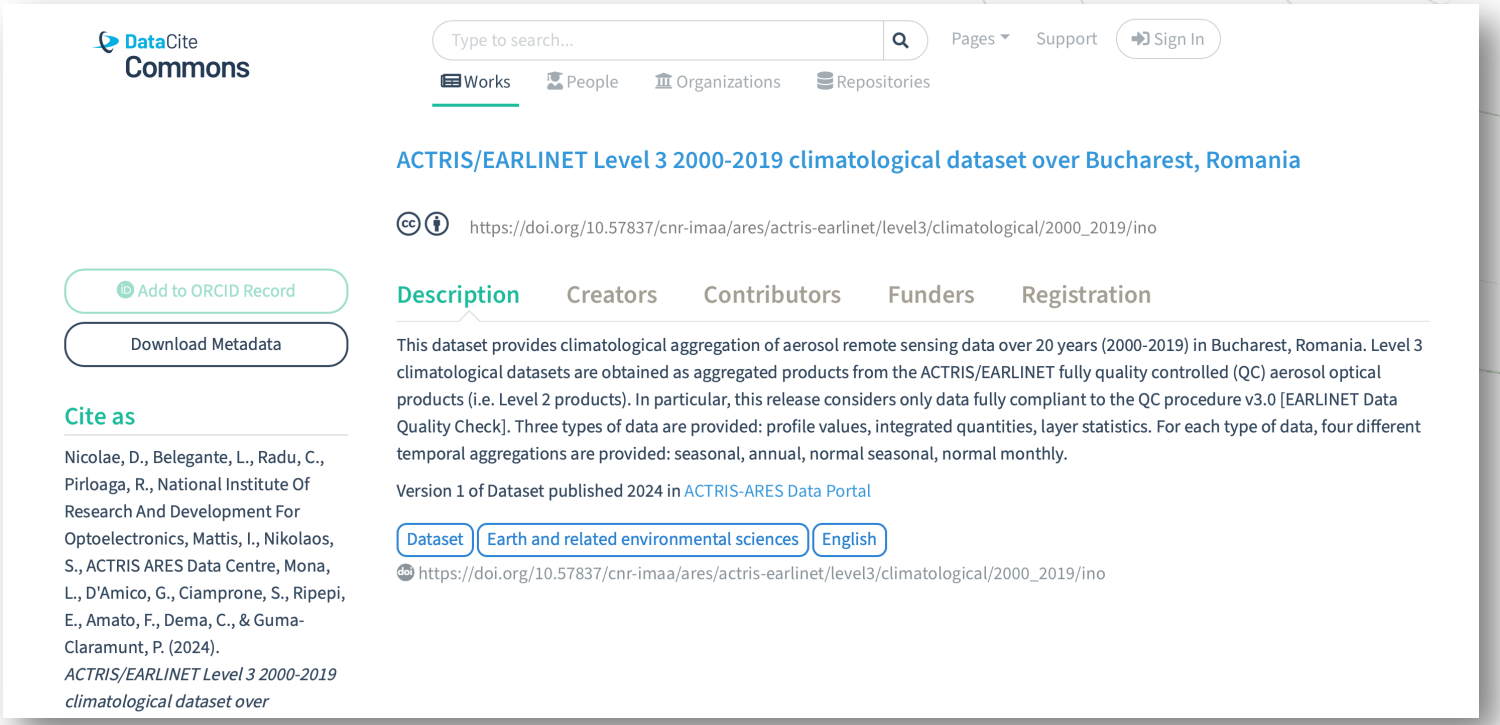
First ARES DOI release – Climatological products

2000-2019 climatological DOIs release: collection



First ARES DOI release – Climatological products

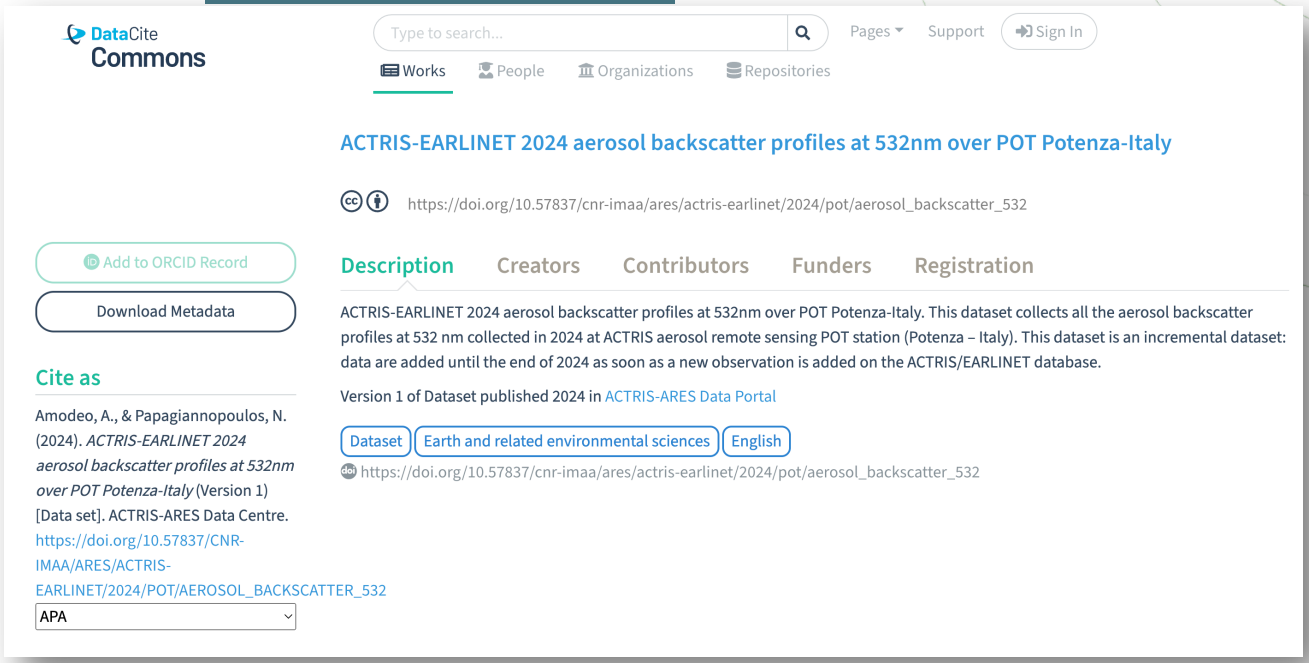
2000-2019 climatological DOIs release: One station example



Annual dataset

- Annual dataset DOI per station per variable per year – 2024

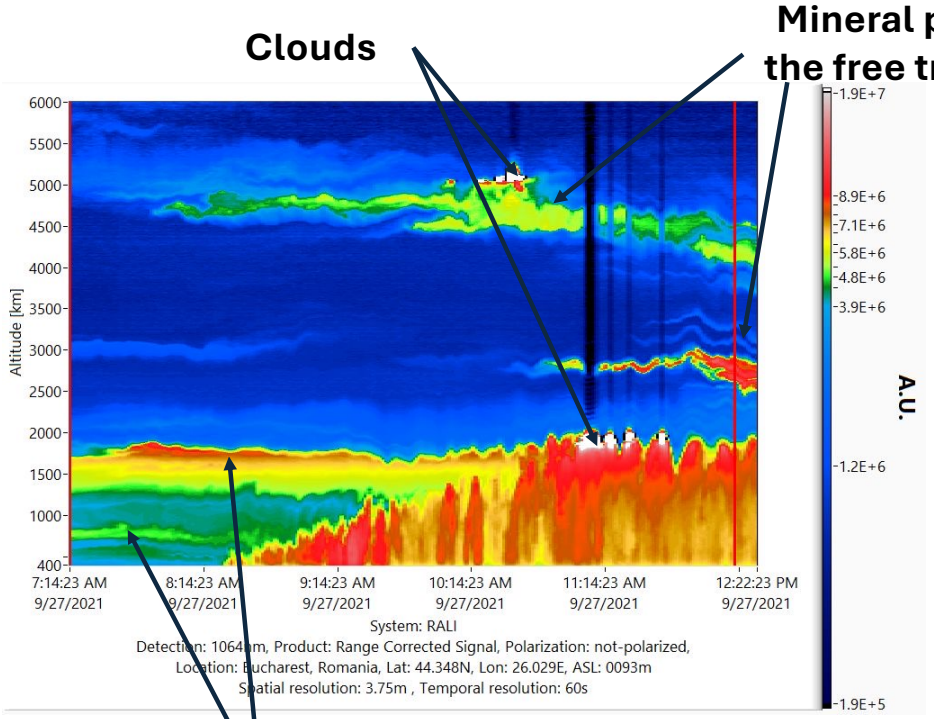
Release by end of 2024 first draft example

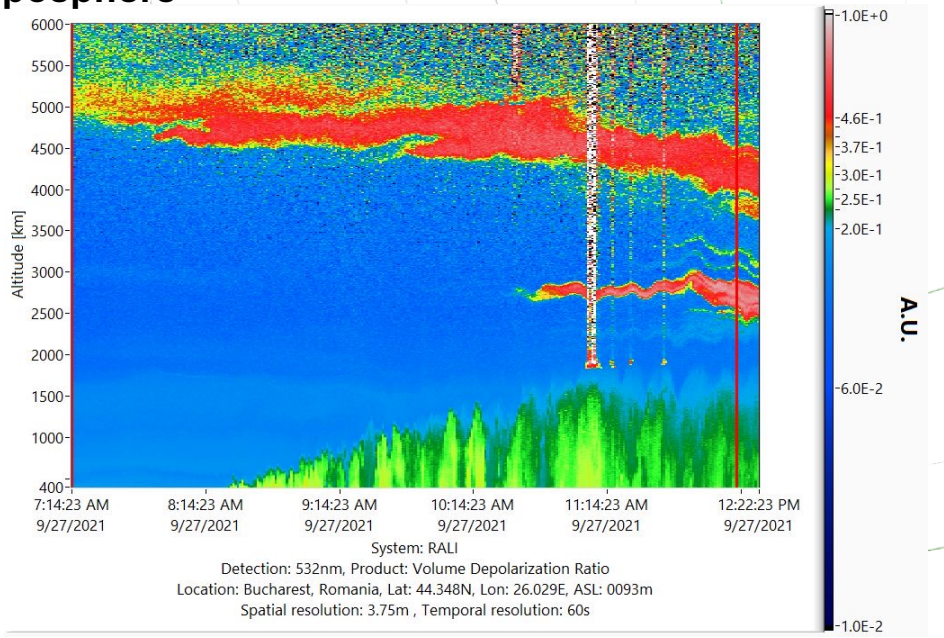


USE CASES

Use case #1

Intrusion of long range transported aerosol in the PBL





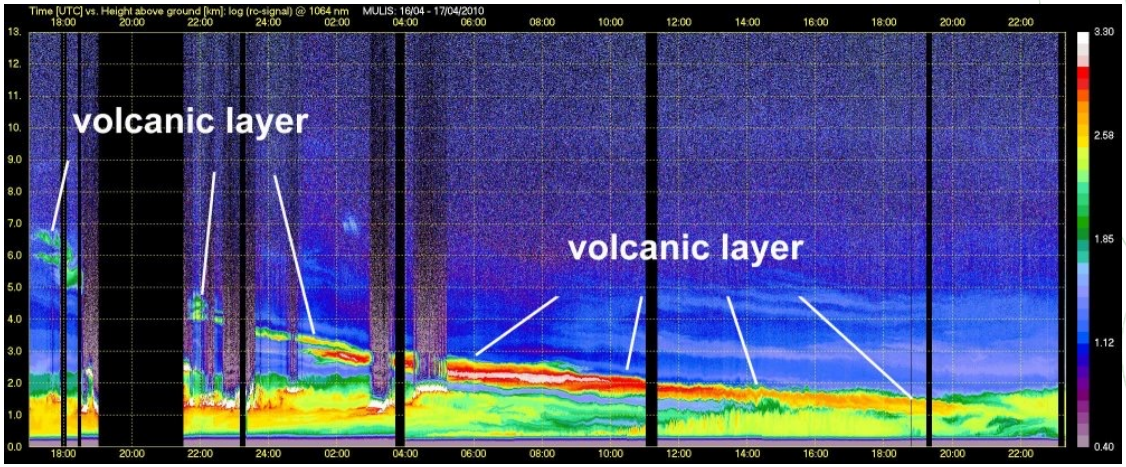
Mixing process investigation

Of interest for air quality, health and ecosystem

Use case #2

Extreme events characterization

Eyjafjallajökull eruption observation over Payerne

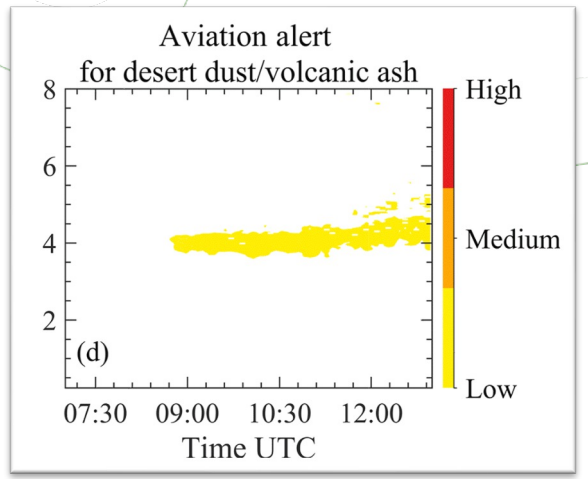


Advanced experimental product for EWS
Ingestion in potentially operational system
Papagiannopoulos et al., ACP, 2020

Hazardous events monitoring and impact mitigations

- Daily report to VAAC
- Database released
- Modification processes over Europe

Pappalardo et al., ACP, 2014

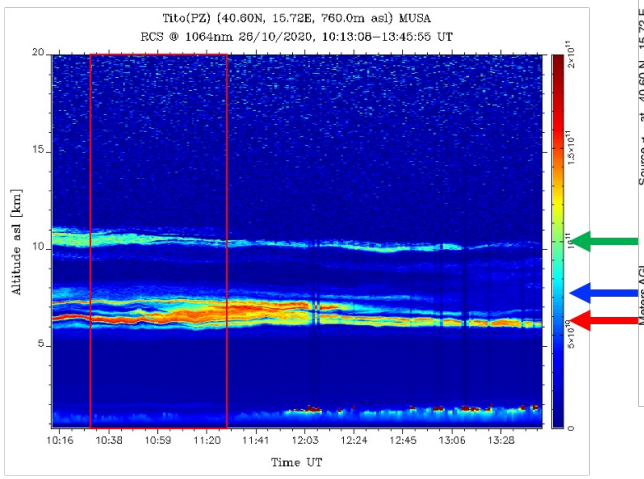


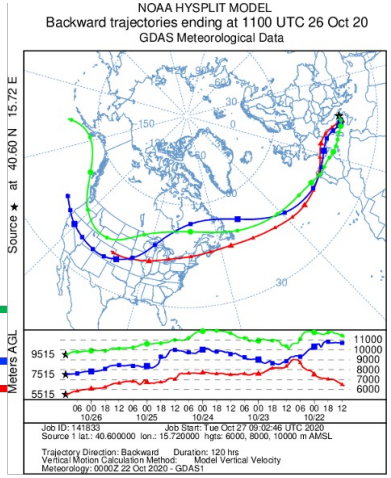
Use case #3

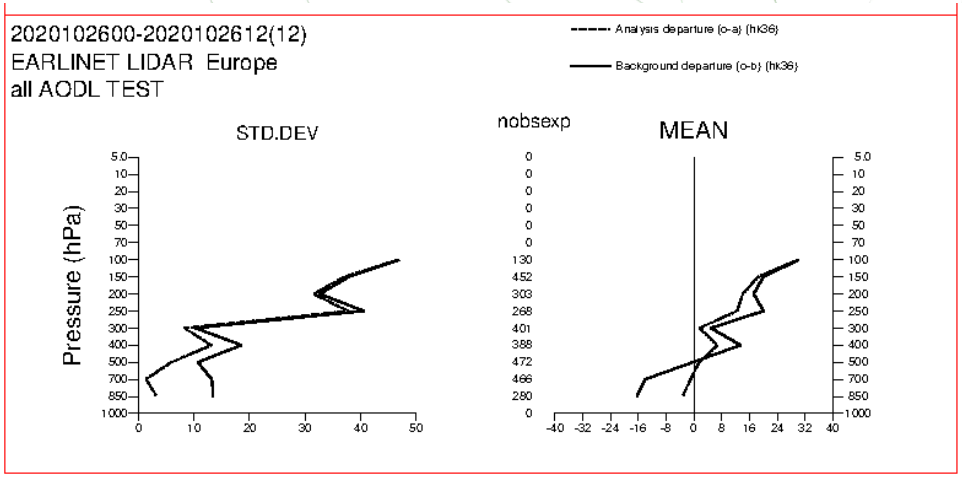
NRT provision

Currently 11 stations are providing data in NRT to CAMS under CAMS21b project (11.2023-09.2027)

Centralized extended QCs in NRT





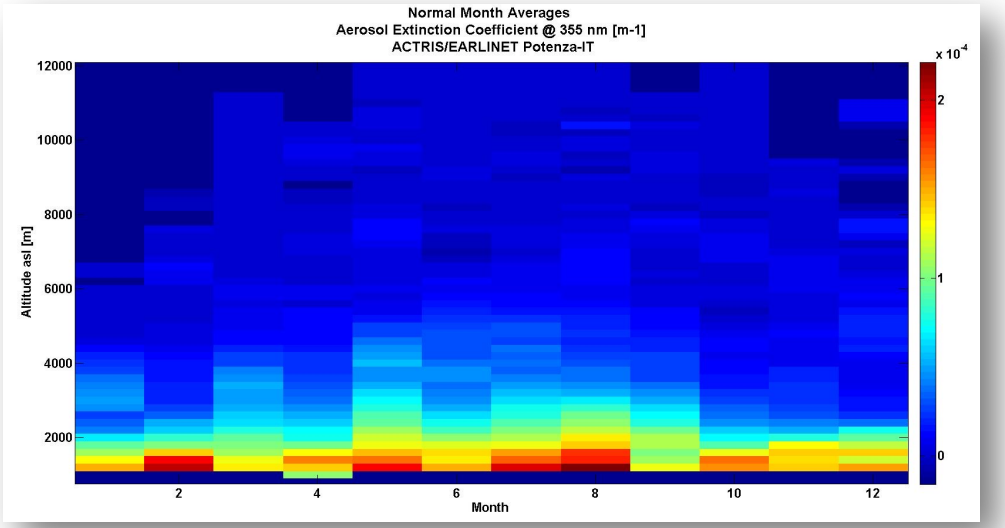


Although few measurements at just 1 site were assimilated some not negligible impacts are visible in the vertical profiles.

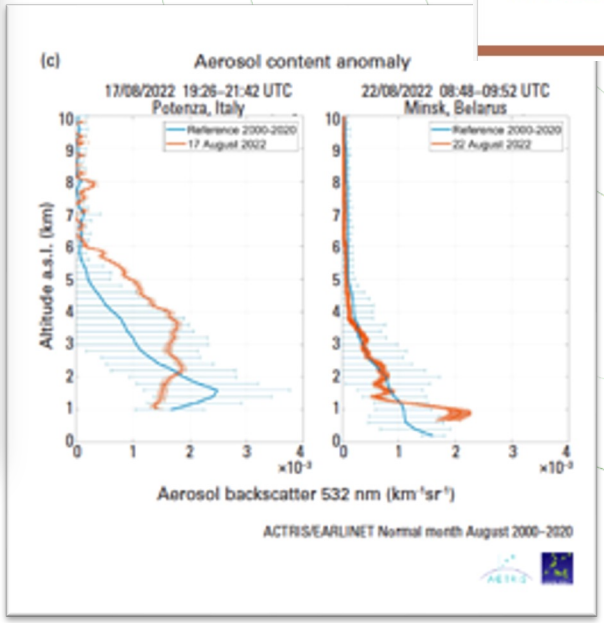
Model improvement through assimilation

Use case #4

Climatological investigation



Assessment of climatic models



Anomalies identification

ITINERIS

THANKS!

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