

ACTRIS Aerosol Remote Sensing in support of EarthCARE Cal/Val

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What is ACTRIS Aerosol Remote Sensing

The chain from data collection to QA/QC data products for aerosol remote sensing measurements

EARLINET

Lidar stations

Lidar Calibration Centre

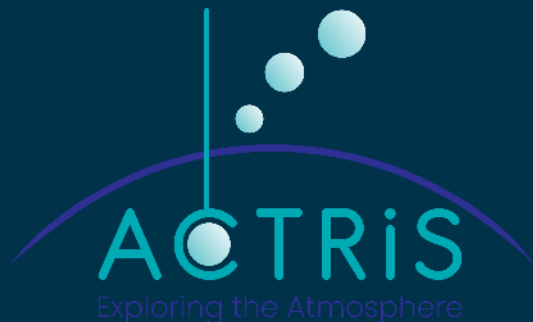
Single Calculus Chain

AERONET-EU

Photometer stations

AERONET-Europe Calibration Service

AEROET-EU processing



Synergy:
GRASP/GARRLIC



- Attenuated backscatter profile
- Volume depolarization profile
- Particle backscatter coefficient profile
- Particle extinction coefficient profile
- Lidar ratio profile
- Angstrom exponent profile
- Backscatter related angstrom exponent profile
- Particle depolarization ratio profile
- Particle layer geometrical properties
- Column integrated extinction
- Column integrated extinction
- Spectral Downward Sky Radiances
- Direct Sun/Lunar Aerosol Optical Depth (column)
- Aerosol columnar properties: fine and coarse modes volume concentrations, size distribution, refractive index

ARES

Aerosol Remote Sensing Unit at the ACTRIS Data Centre

ARES

Centralized data processing

CARS

Centre for Aerosol Remote Sensing

CARS

Centralized support for QA/QC

ARS National Facilities

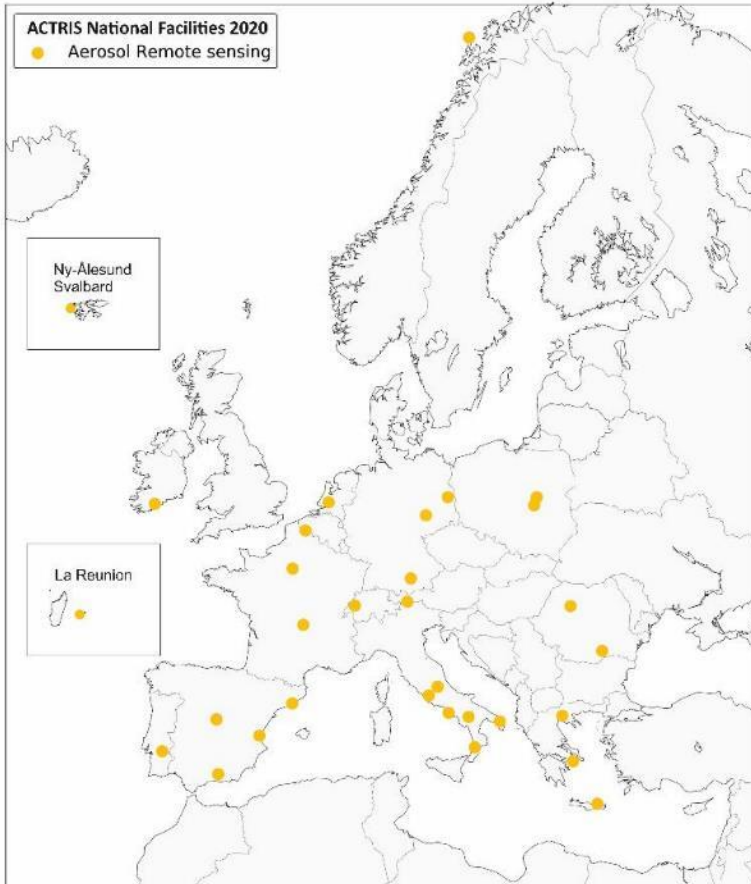
Stations operating co-located aerosol lidars and photometers

ARS National Facilities

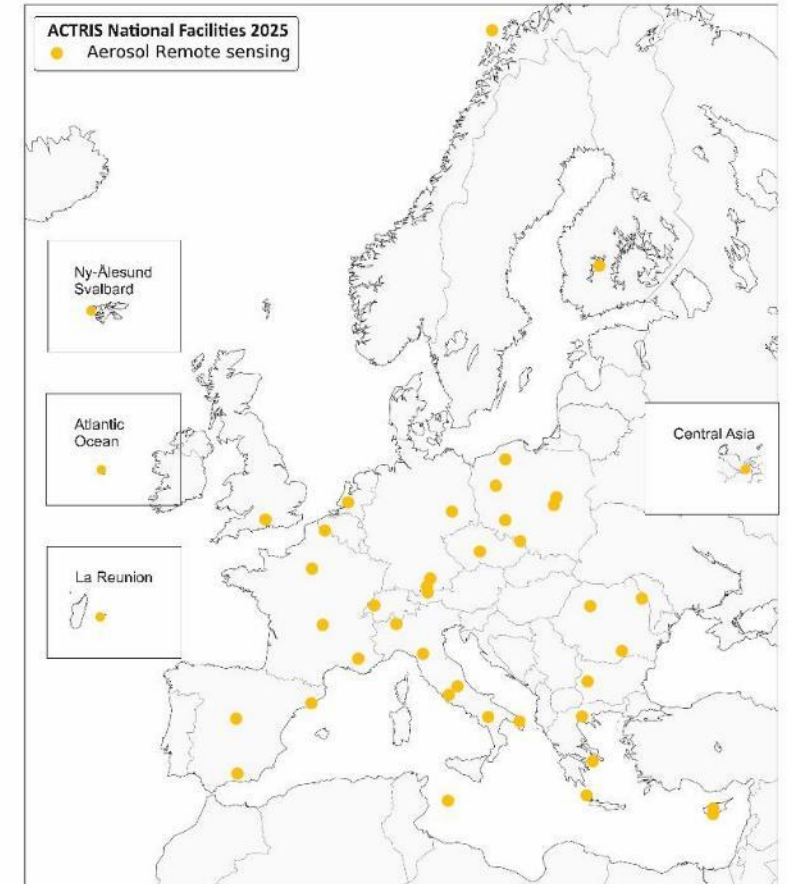
Aerosol lidar
Sun/sky/lunar photometer

Aerosol remote sensing in ACTRIS

2021
Total: 30



2025
Total: 51



Aerosol remote sensing data workflow

Before ACTRIS

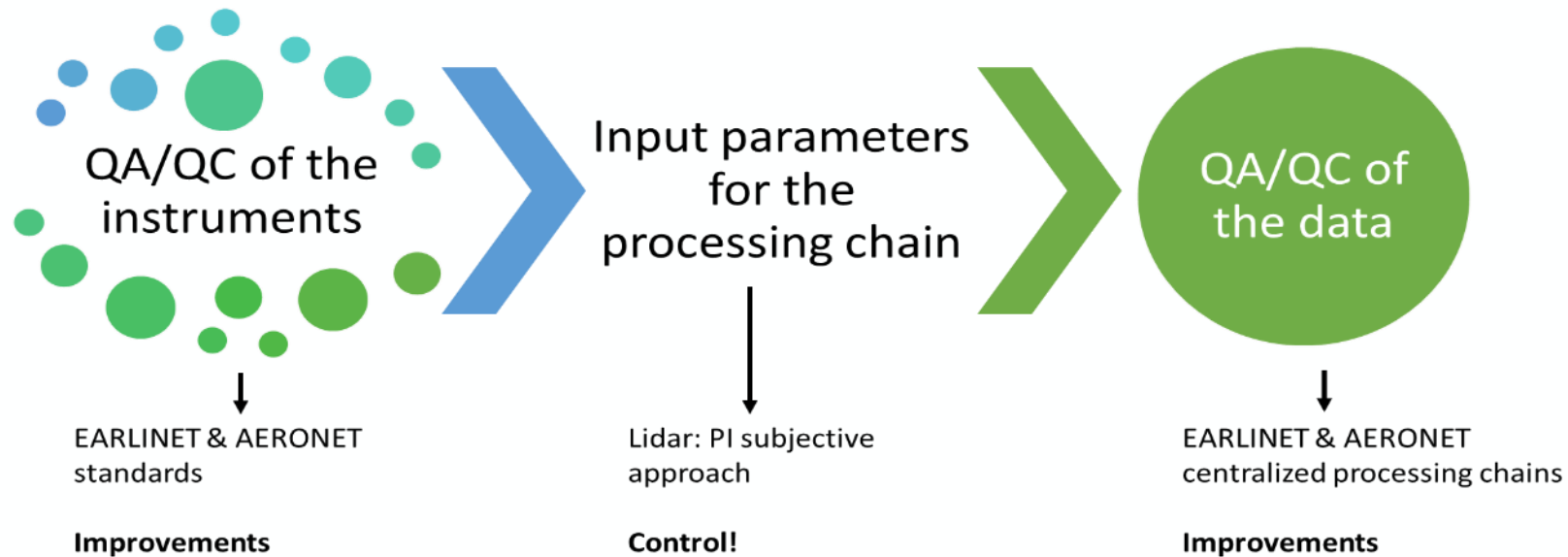
Mainly based on the expertise of the PI

Long process

Differences in data treatment (the use of the SCC not mandatory)

Many rejected datasets (QC at the EARLINET db side)

Inhomogeneity of the datasets



CARS provides

- Guidelines for instrument design and setup
- Standard Operation Procedures
- Standard Quality Assurance tests
- Software tools for controlling the status of the instrument at its location
- Check of the photometer data

CARS organizes

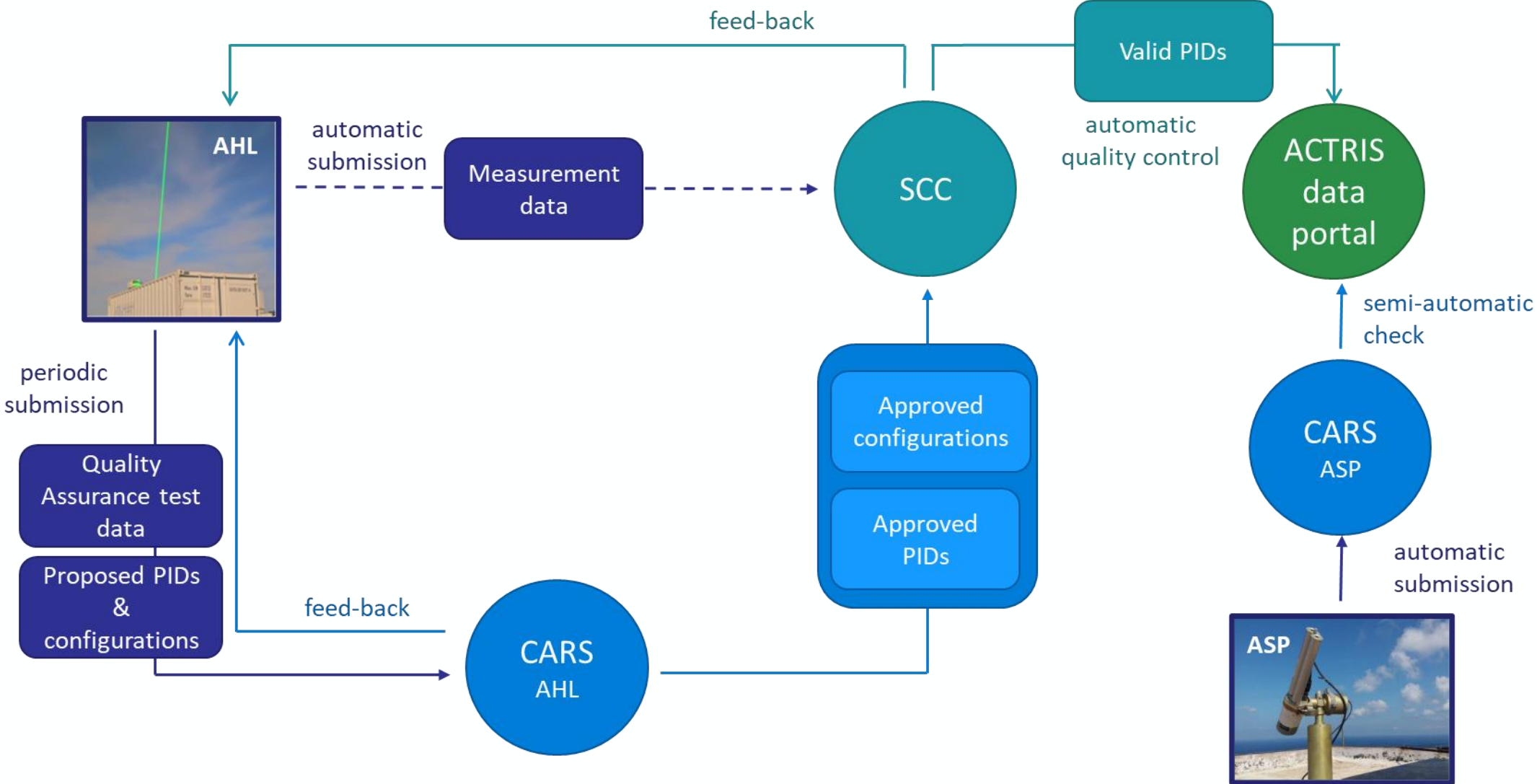
- Annual calibration of photometers
- Continuous QC of the photometer level 1 data
- Annual expert analysis of the lidar QA/QC tests
- Occasionally (~ each 5 years) direct comparisons with reference lidars (funding!)

ARES ensures

- Centralized processing of lidar raw datafiles – Single Calculus Chain (SCC)
 - Blocking of configuration of the centralized software
 - Centralized automatic quality control of the data
- Aerosol profile and columnar data products: various levels: partially (level 1) or fully (level 2) quality assured
 - High and low resolution total attenuated backscatter and volume depolarization ratio time series
 - Aerosol extinction, backscatter, lidar ratio, angstrom exponent and depolarization ratio vertical profiles
 - Columnar information and aerosol microphysical properties profiles
 - Synergistic lidar/photometer products as vertical profiles of aerosol microphysical properties.
- Statistical analysis (including seasonality and annuality) of the most important aerosol optical parameters (level 3)
- Traceability of the data

Aerosol remote sensing data workflow

Now in ACTRIS



- **CALIPSO**

- EARLINET started correlative measurements for CALIPSO on 14 June 2006, i.e. at the beginning of the CALIPSO operation.
- NASA provides weekly forecast of CALIOP track with 1sec resolution
- Overpasses distributed centrally to all the stations (100 km)
- Data centrally flagged as CALIPSO overpasses related

- Follow-ups

- EARLINET worked on CALIPSO validation and exploitation even under ESA contract (like ESA-CALIPSO and LIVAS)

- **AEOLUS**

- EARLINET & CLOUDNET (ACTRIS) are now working for Aeolus Cal/Val

Lessons learned from the validation of Aeolus L2A product with EARLINET, Nikos Siomos - NOA

Examples from CALIPSO Cal/Val

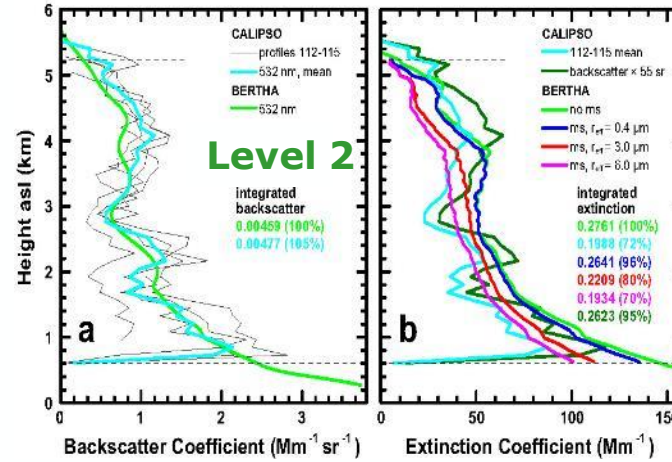
Methodology for Attenuated Backscatter comparison was developed and applied to the network observations [Mona et al., 2009; Pappalardo et al., 2010]

Comparison of optical properties for feedback on the methods/algorithms [e.g. Wandinger et al., 2010]

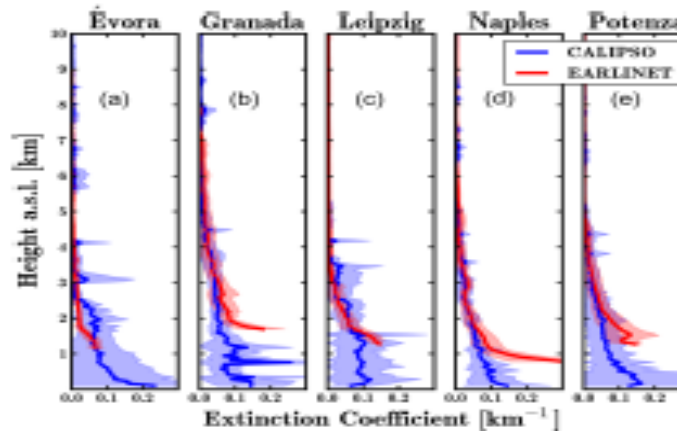
Evaluation of climatological products and investigation of potential improvements at climatological scale in terms of typing/lidar ratio assumptions [Papagiannopoulos et al., 2016]

Many studies combining CALIPSO and EARLINET data for a better understanding of 4d aerosol field characteristics [Pappalardo et al., 2010] and taking the most of high quality EARLINET data and CALIPSO coverage [Amiridis et al., 2015]

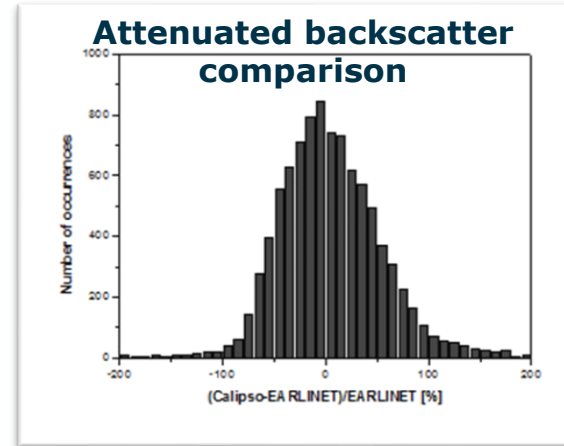
Optical properties comparison



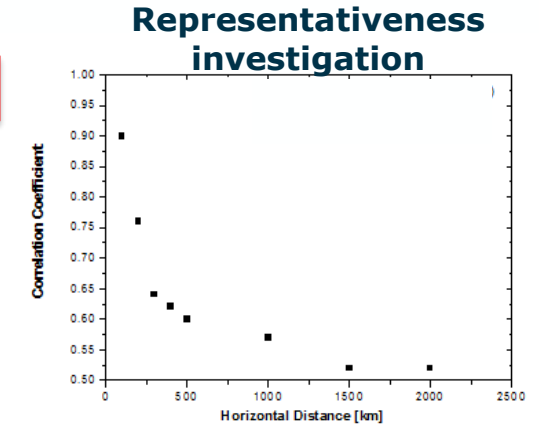
Climatological products



Level 1

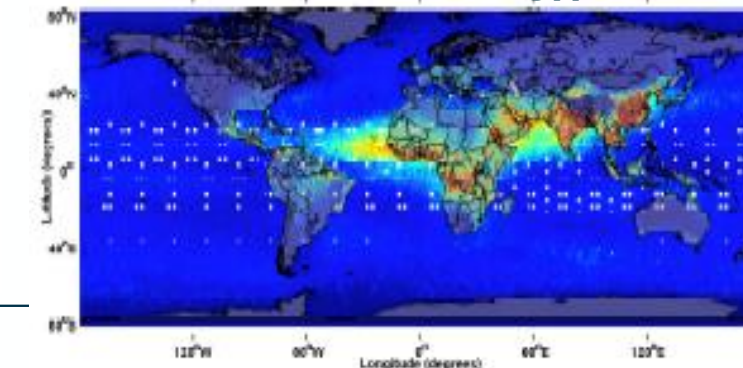


Level 2



Level 3

Synergy CALIPSO-EARLINET-aerosol model (LIVAS-AOD climatology)

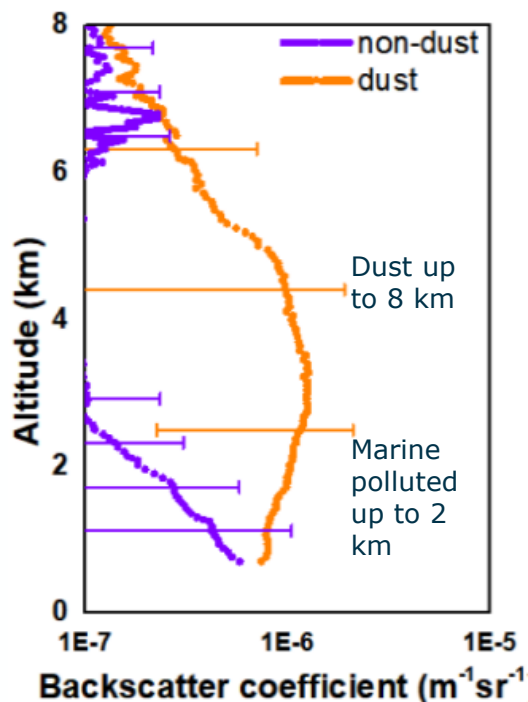


Testing of the new workflow: ACTRIS/EARLINET COVID-19 campaign

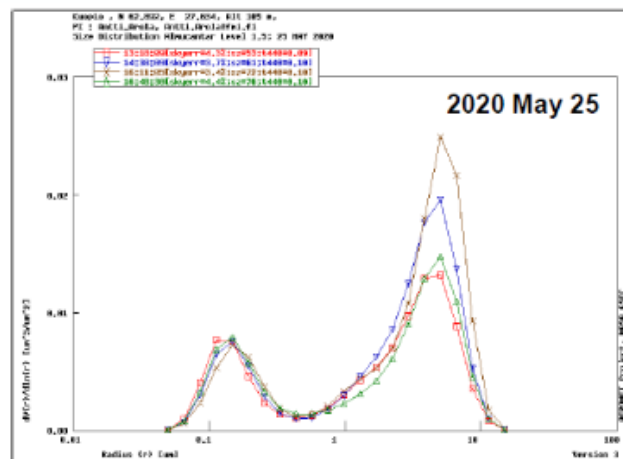


- Intensive observation campaign May 2020
 - 21 participating stations
 - NRT processing → fast analysis → SCC server, not public
 - QA tests + measured meteorological fields → re-analysis → EARLINET/ACTRIS database, public
 - 693 datasets collected
 - 3473 data products calculated
 - > 2500 data products in the ACTRIS Data Portal
- Fast processing and analysis of the existing measurements Jan. Apr. 2020
- CARS-ARES workshop, online, 6-8 July 2020
 - Coordinated studies
 - Technical aspects
 - Studies at individual stations
 - Publications

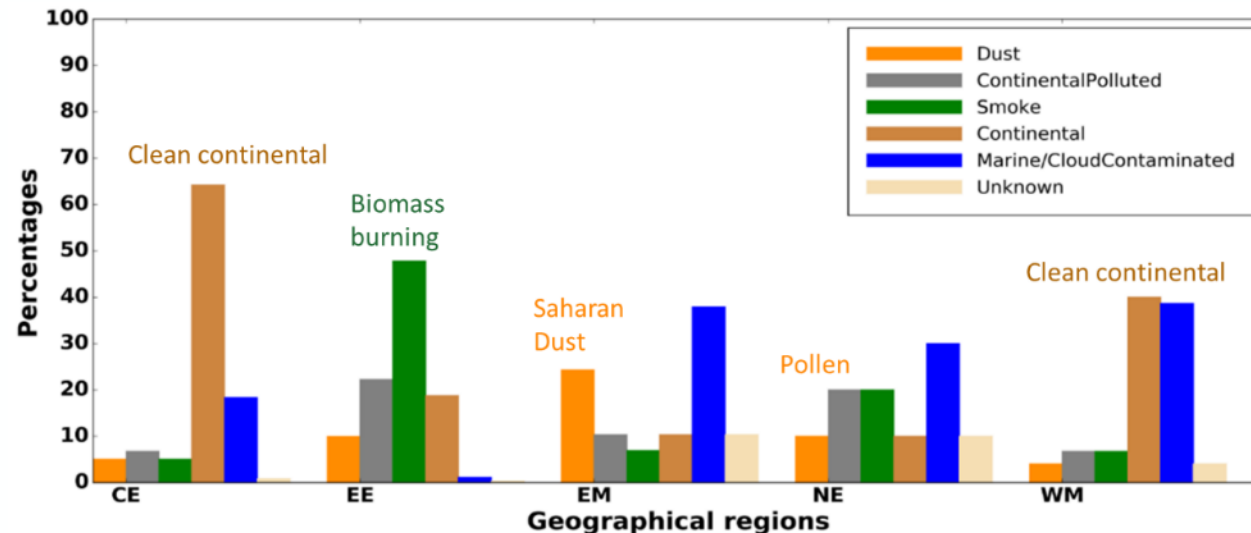
Testing of the new workflow: ACTRIS/EARLINET COVID-19 campaign



Separation of dust and non-dust backscatter @Antikythera; courtesy of Eleni Marinou et al., NOA



Pollen as seen by the photometer @Kuopio; courtesy of Mika Komppula et al., FMI



Preliminary findings

- Slightly decreased AOD (photometer)
- Slightly increased Angstrom (photometer and lidar), especially in the low troposphere (lidar)
- Less absorbing particles (lidar and photometer)
- More non-spherical particles (lidar)

Detailed analysis on-going for several publications

Use of a similar approach as for Calipso and Aeolus, but:

New workflows

New QA/QC procedures

—————→ *More automatic data tagging and transfer is under development*

Kind request:

- Forecast of 1-sec resolution track of the lidar sensor → direct transfer to ARES (for the involved aerosol remote sensing stations) → automatic tag “EarthCARE correlative”
- Fast access to X-MET product (ARES) → NRT level 2 data products (correlative)
- Fast access to ECMWF forecasted meteorological fields (ARES) → NRT level 2 data products (all)

Advanced products based on QC EARLINET data and EarthCARE observations

- Differences of correlated observations as a function of the interesting parameters (e.g. locations, day/night conditions, aerosol type, observed ext/backscatter), annual release

Other specific needs for the Cal/Val?

- Please formulate them: higher frequency for dataset released, other parameters of interest, etc.?
- Can be accommodated through agreements and making use of access to virtual services of ACTRIS

Thank you for your time.



<https://www.actris.eu/>

