Ground based observations: status & data access points and digital tools

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IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
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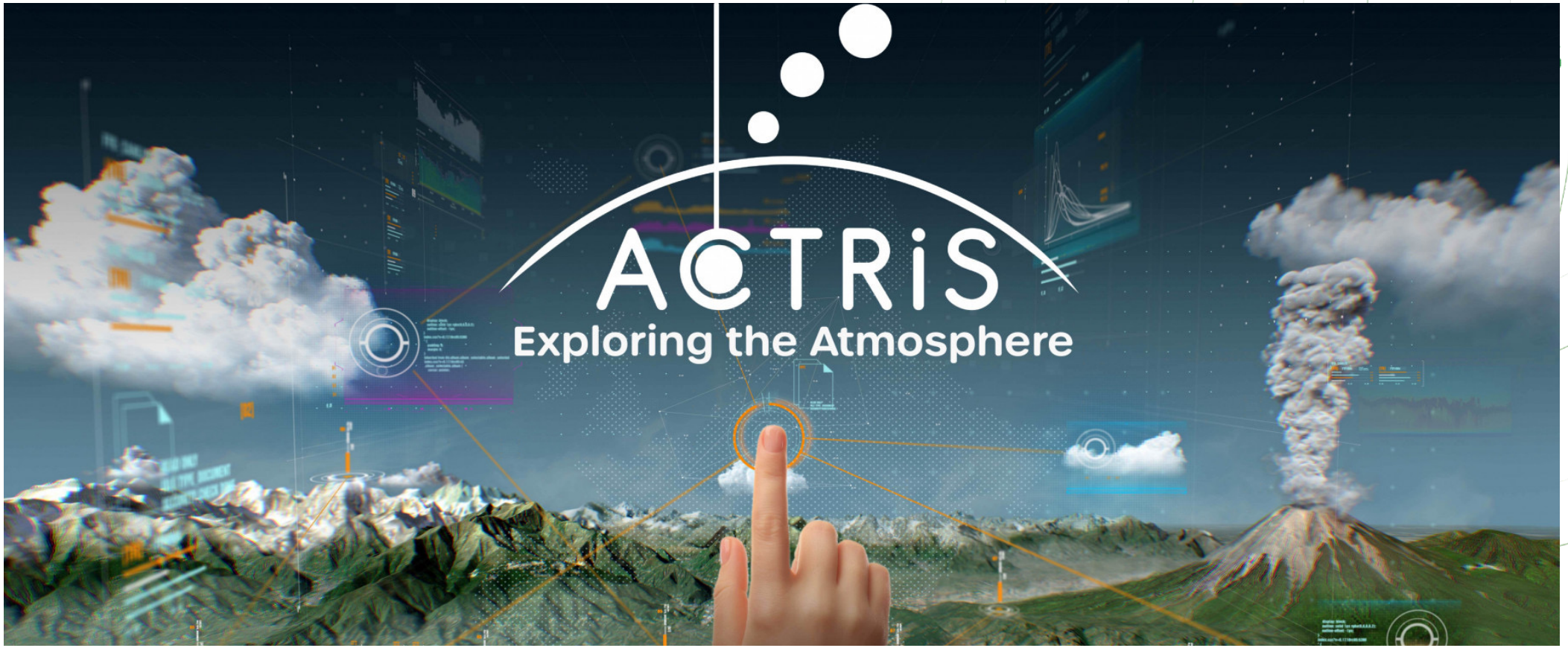
Finanziato dall'Unione europea NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani

Overview

- ACTRIS – What is it?
- Type of variables in ACTRIS
- ACTRIS Data Centre
- FAIR data
- Data Access Points
- Services & tools
- Use cases

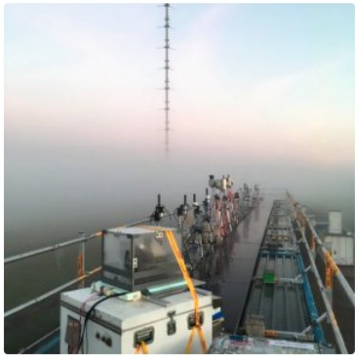


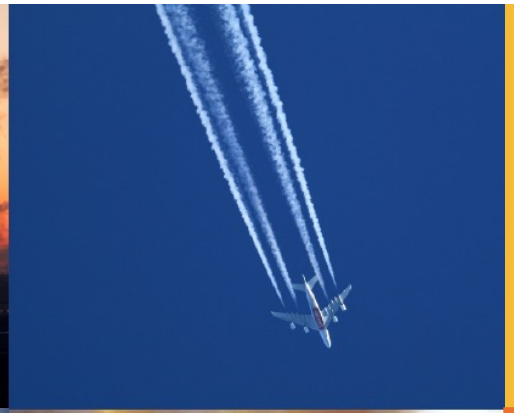
ACTRIS-
Aerosol Cloud and TRace gas Research Infrastructure

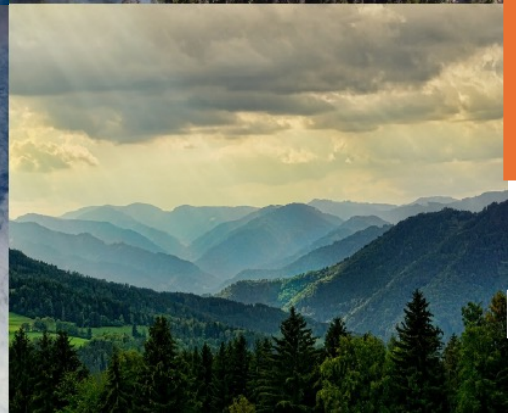
What is ACTRIS?

ACTRIS is a pan-European **distributed research infrastructure** producing high-quality data and information on short-lived **atmospheric constituents** and on the processes leading to the variability of these constituents in natural and controlled atmospheres.

ACTRIS is key to supporting scientific advances in the field of atmospheric research







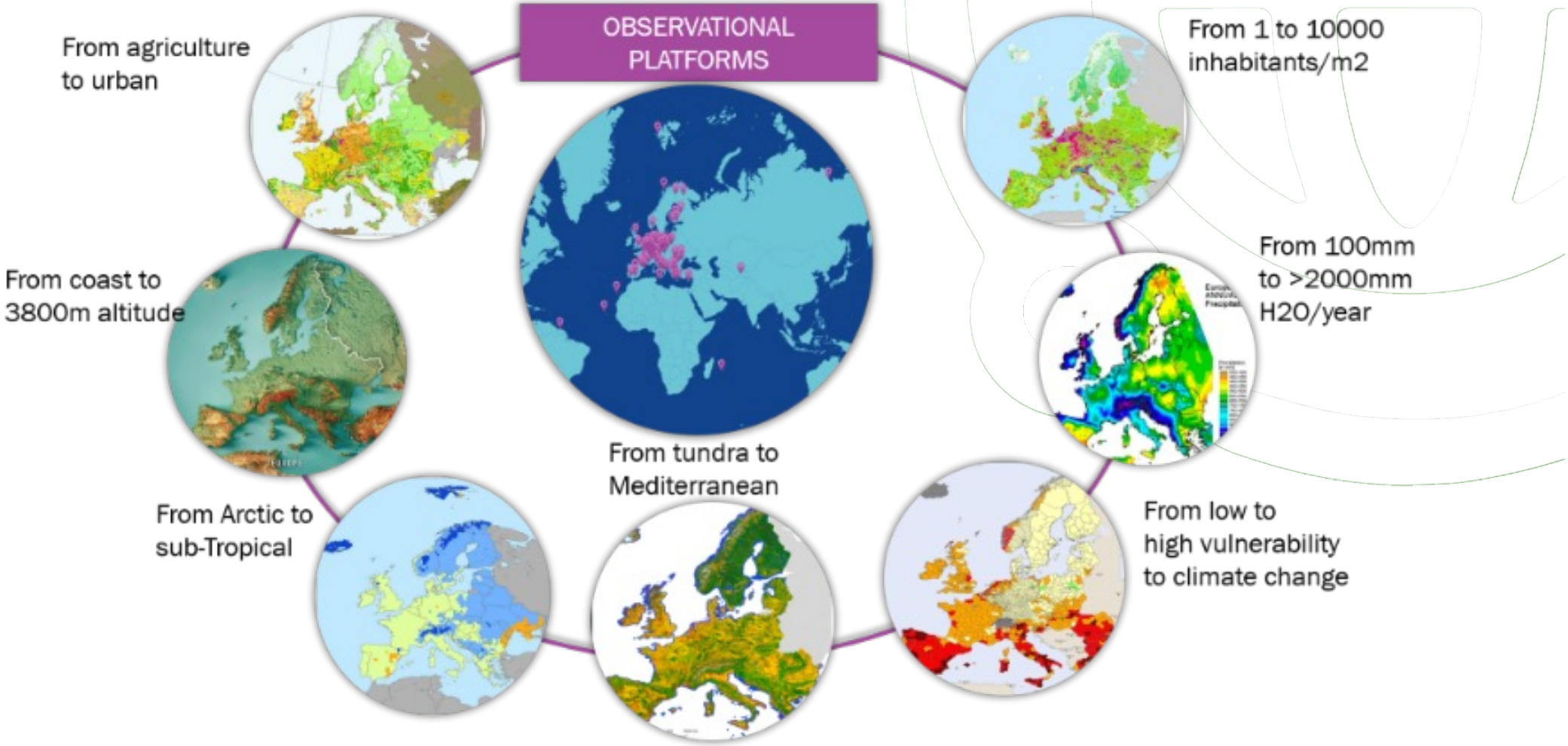
Short-lived atmospheric constituents

< 150 atmospheric variables

Composition
Properties
Processes
Emissions
Transport
Removal
Trends
Feedbacks

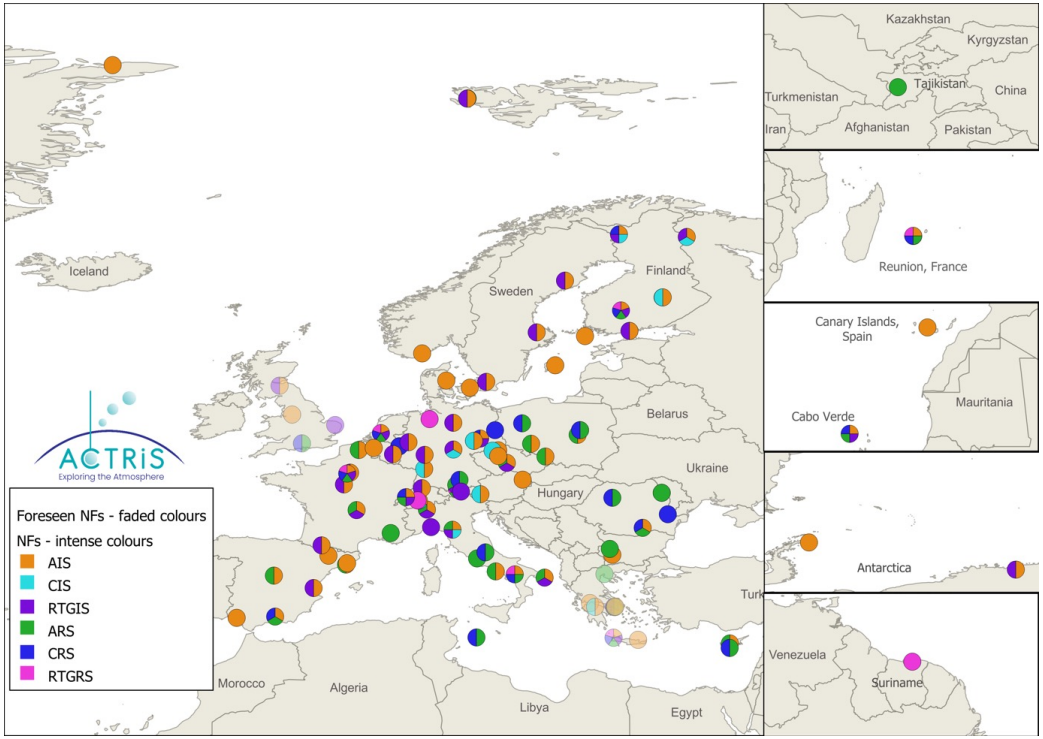
Coverage of different climates, land uses and ecoregions

Coverage of different climates, land uses and ecoregions



Core Asset: ACTRIS National Facilities

The National Facilities are the heart of atmospheric scientific excellence



- Aerosol in-situ
- Cloud in-situ
- Reactive trace gas in-situ
- Aerosol remote sensing
- Cloud remote sensing
- Trace gas remote sensing

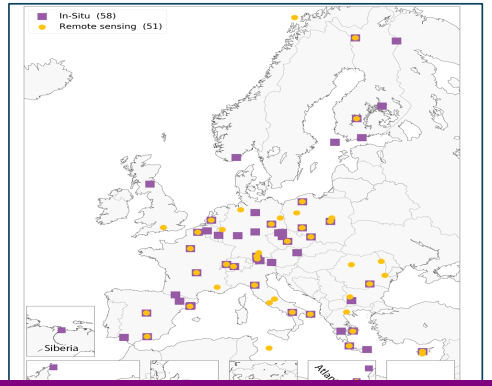
Laj, Myhre, Riffault et al. BAMS 2024, https://doi.org/10.1175/BAMS-D-23-0064.1

Harmonized methods → Calibrated instruments → Provision of data → Qualified data production → Curation of data → Access to users

ACTRiS Topical Centers

Centre for Aerosol In Situ Measurements
Centre for Aerosol Remote Sensing
Centre for Cloud In Situ Measurements
Centre for Cloud Remote Sensing
Centre for Reactive Trace Gases In Situ Measurements
Centre for Reactive Trace Gases Remote Sensing

ACTRiS National Facilities

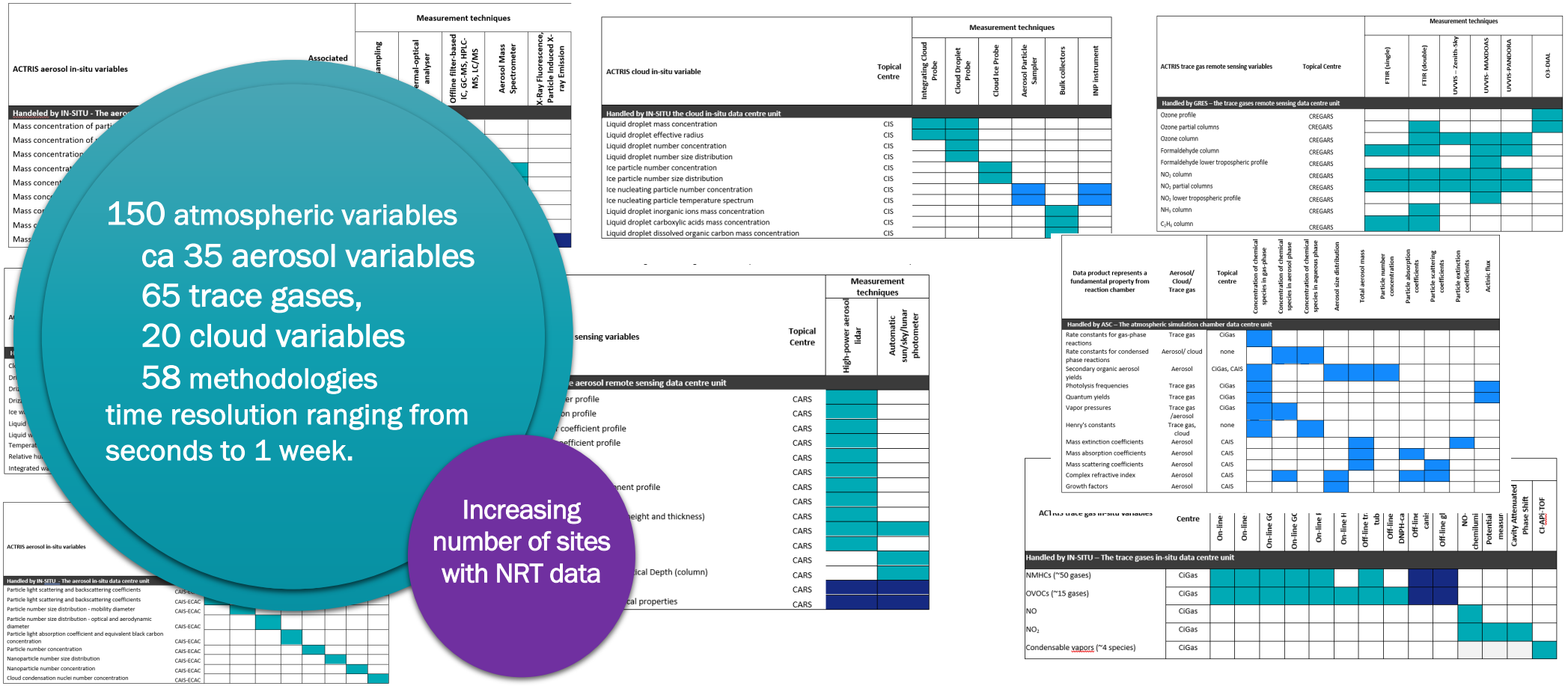


ACTRiS Data Center

In situ Data Centre Unit (In-Situ)
Aerosol remote sensing Data Centre Unit (ARES)
Cloud remote sensing Data Centre Unit (CLU)
Trace gas remote sensing Data Centre Unit (GRES)
Atmospheric simulation chamber Data Centre Unit (ASC)

Qualify for ACTRIS NF – set of variables at the sites
Or ACTRIS compliant data – follow all ACTRIS recommendations

ACTRIS variables and associated methodologies



Laj, Myhre, Riffault et al. BAMS 2024, https://doi.org/10.1175/BAMS-D-23-0064.1

ACTRIS variables and associated methodologies

Laj et al, accepted for publication in BAMS April 2024

Aerosol, Clouds and Trace Gases Research Infrastructure – ACTRIS, the European research infrastructure supporting atmospheric science

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g *Department of Physics, University of Cologne, Cologne, Germany*
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i *ACTRIS ERIC, Helsinki, Finland*

ACTRIS Data Centre

150 atmospheric variables
ca 35 aerosol variables
65 trace gases,
20 cloud variables
58 methodologies
time resolution ranging from seconds to 1 week.

Increasing number of sites with NRT data

The mission of the ACTRIS Data Centre (DC) is to compile, archive and provide access to well documented and traceable ACTRIS measurement data and data products, including digital tools for data quality control, analysis, visualization, and research.

As a tool for science, the highest priorities for the ACTRIS DC are to maintain and increase the availability of ACTRIS data and data products relevant to climate and air quality research for all interested users.

ACTRIS Data Centre

In situ Data Centre Unit (In-Situ)	Aerosol remote sensing Data Centre Unit (ARES)	Cloud remote sensing Data Centre Unit (CLU)	Trace gas remote sensing Data Centre Unit (GRES)	Atmospheric simulation chamber Data Centre Unit (ASC)

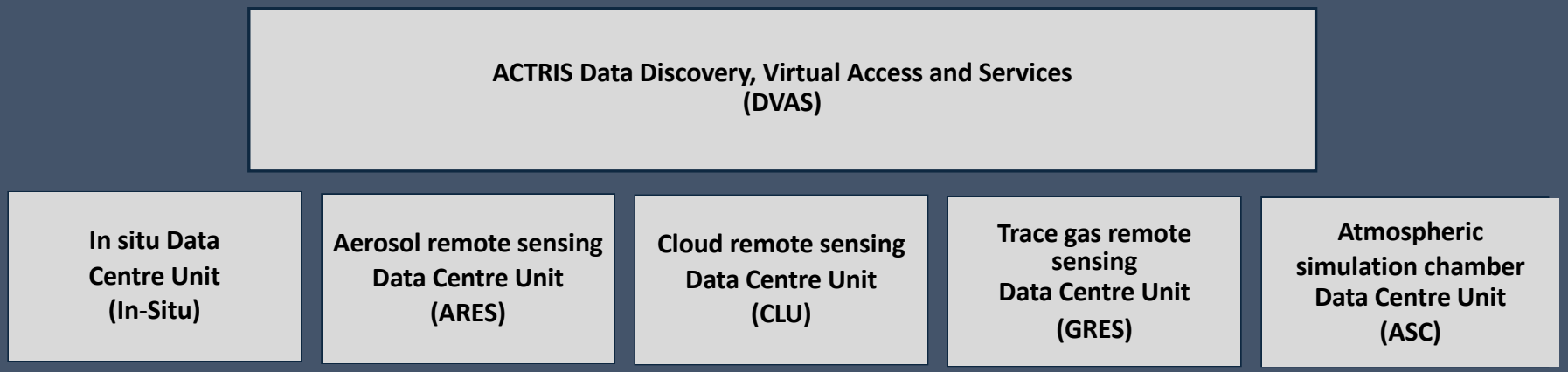
National Facilities

Providing standardized and harmonised data. The extent of data contributions varies from each National Facility

Topical Centres

Ensuring compliance with ACTRIS requirements on data quality, methods, …

ACTRIS Data Centre



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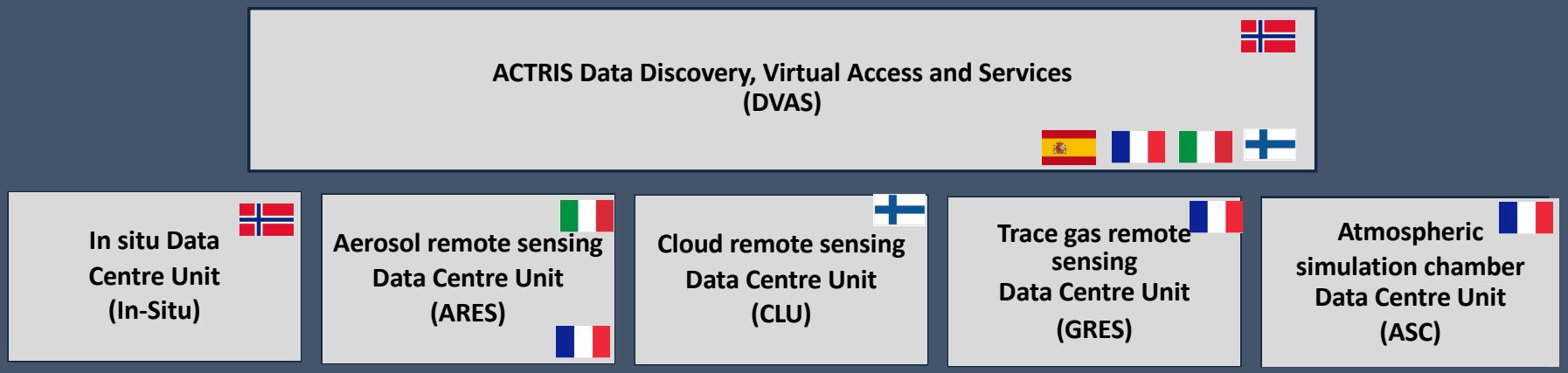
ACTRIS Data Centre



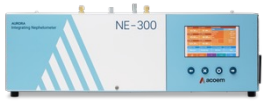
National Facilities

Providing standardized and harmonised data. The extent of data contributions varies from each National Facility

Topical Centres

Ensuring compliance with ACTRIS requirements on data quality, methods, …

ACTRIS In Situ Unit: Aerosol, Trace gas & Clouds



CAIS-ECAC
Center for Aerosol In-Situ - European Center for Aerosol Calibration and Characterization

ACTRiS
Data Centre
In Situ Unit

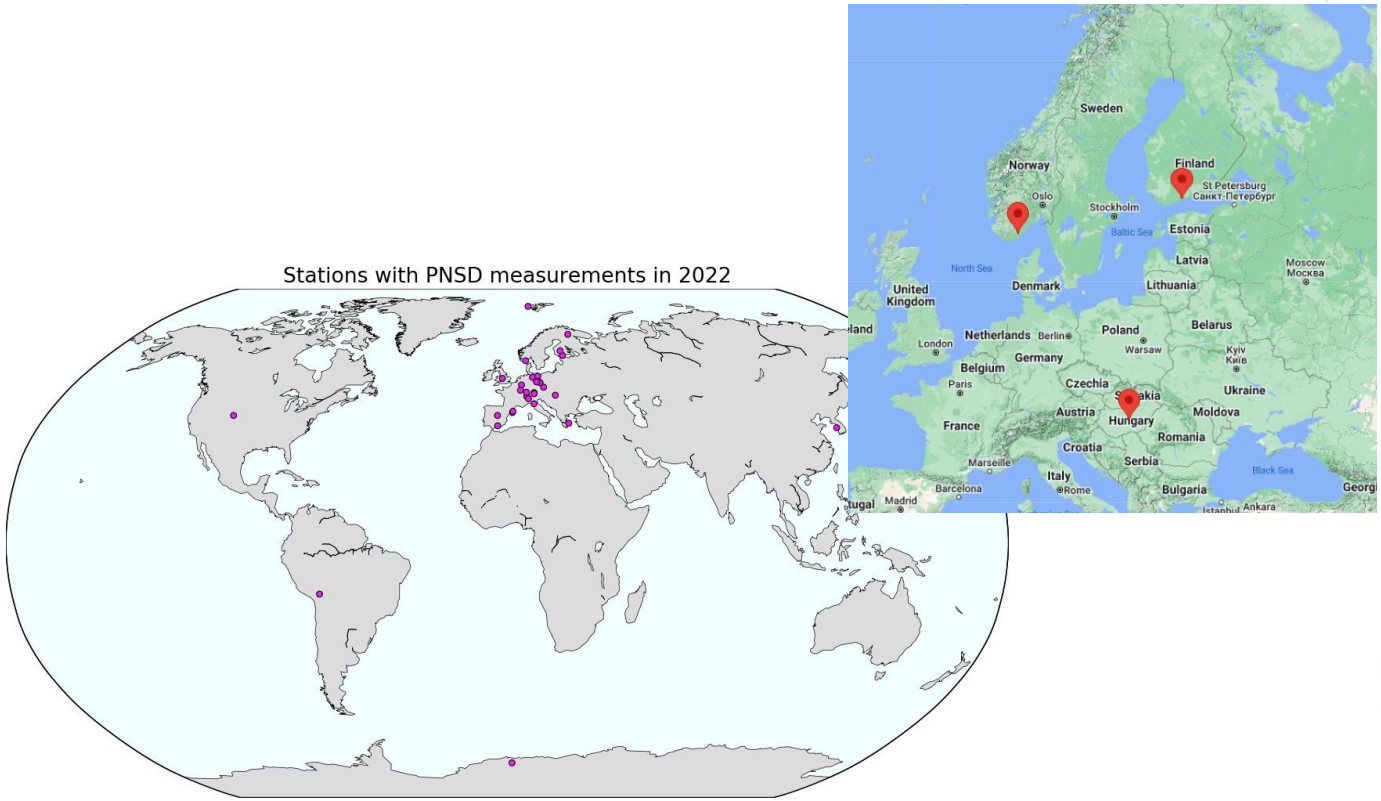
ACTRIS ITINERIS

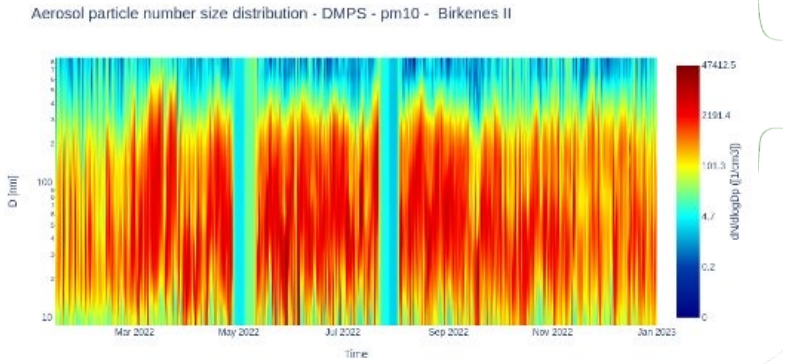
CIS

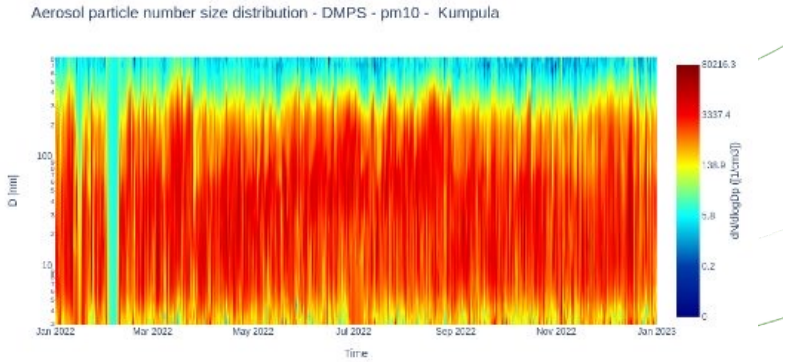
CiGas

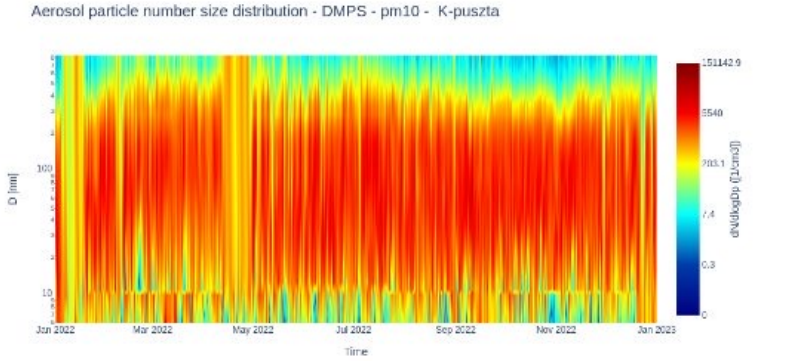
European Commission | Copernicus Europe's eyes on Earth | ECMWF

Some examples:
Aerosol particle number size distribution

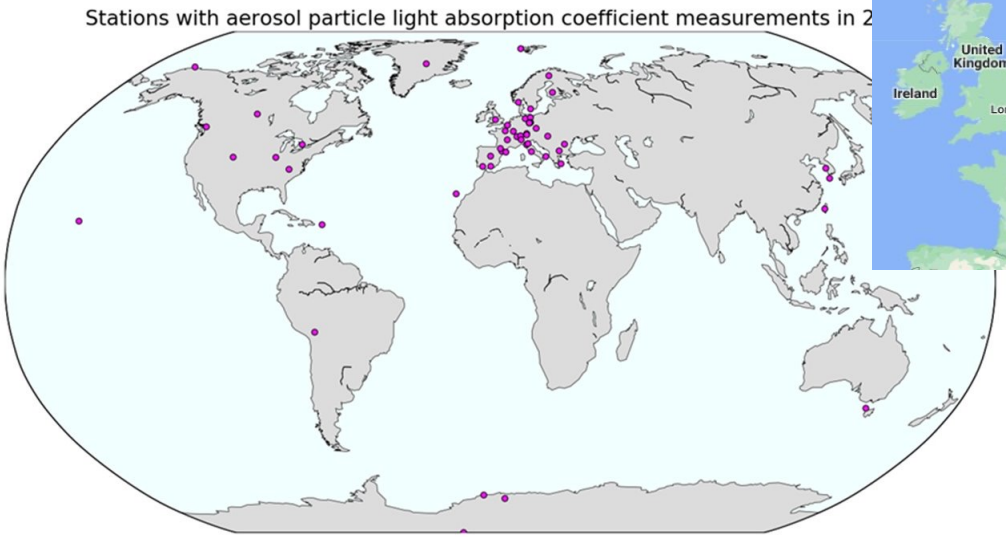


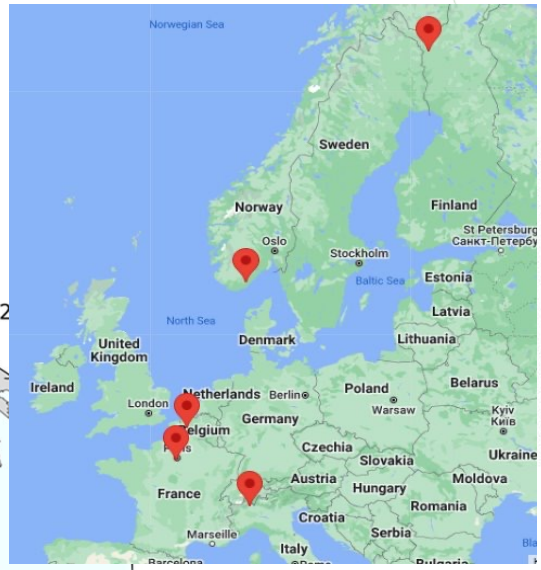


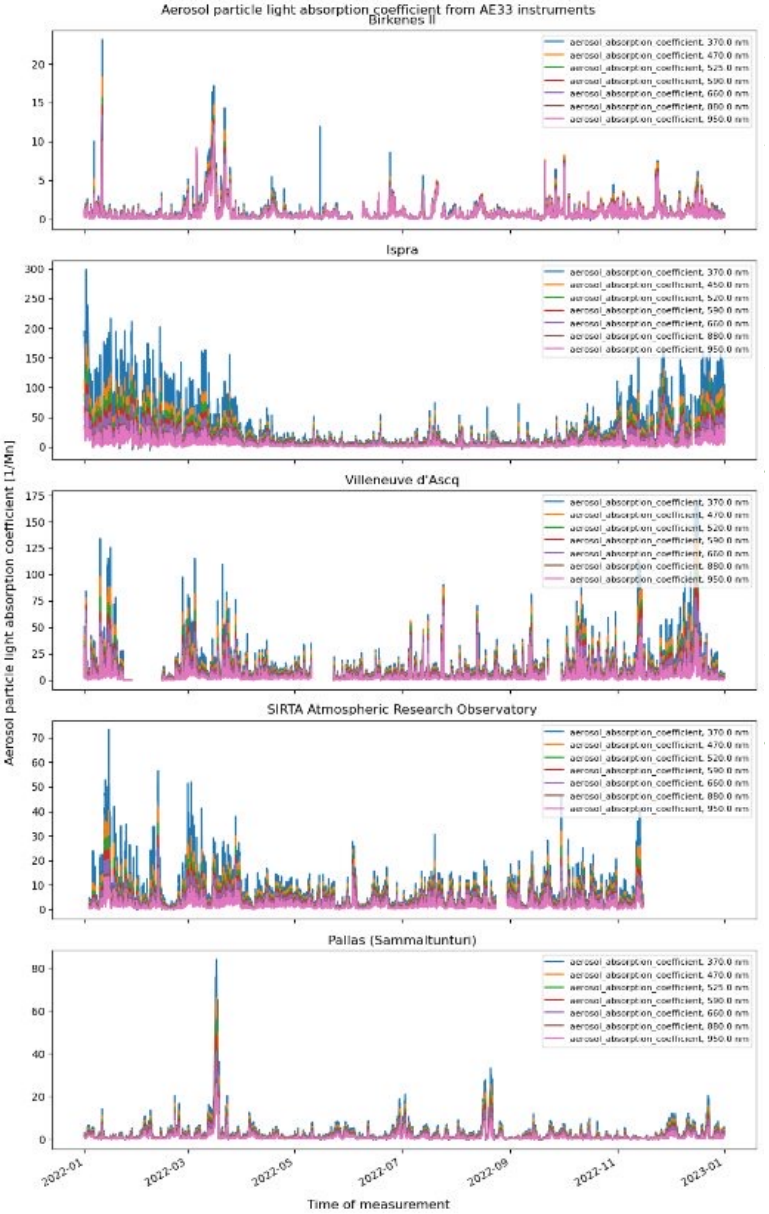




Some examples:
Aerosol particle light absorption coefficient







ACTRIS Aerosol In Situ Real-Time Variables

integrating nephelometer
aerosol particle light scattering coefficient
aerosol particle light backscattering coefficient

Filter absorption photometer
aerosol particle light absorption coefficient

condensation particle counter
aerosol particle number concentration

ACTRIS In Situ station

Continuous data provision:

- 24 h per day.
- 365(366) days per year.
- Except calibration periods.

particle mass spectrometer
aerosol particle chemical speciation

mobility particle size spectrometer
aerosol particle number size distribution

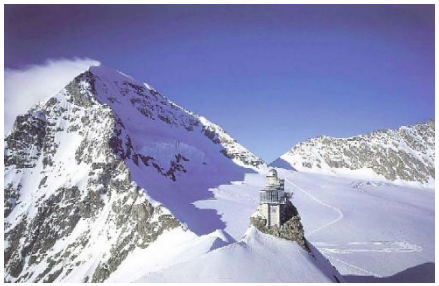
ACTRIS Tracegas In Situ Real-Time Variables

Photo: https://agage.eas.gatech.edu/

gas chromatograph / mass spectrometer (GC-MS)
volatile organic compound concentrations

Photo: https://www.tesscorn-aerofluid.com/

Proton Transfer – Mass Spectrometer (PTR-MS)
volatile organic compound concentrations



ACTRIS In Situ facility

Continuous data provision:

- 24 h per day.
- 365(366) days per year.
- Except calibration periods.

Photo: Teledyne

Chemiluminescence detector + photolytic converter
NO, NO_2, NO_x concentrations

Photo: Thermo Fisher

UV differential absorption photometer
ozone concentration

ACTRIS ARES Unit: Aerosol Remote Sensing

Aerosol Remote Sensing National Facilities

Provision of Data

CARS Central Facility

QA test results

ACTRIS – ARES Unit

Services provided:

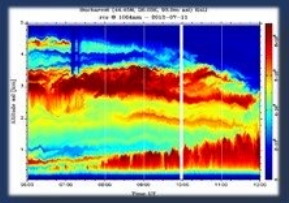
- Unique access point for aerosol remote sensing (meta)data and data products
- Tools for data upload, visualization and handling
- Quality Assurance / Quality Check
- Long term sustainable archive
- Data Versioning
- Central data processing (SCC)
- Training / Support
- Traceability
- Reprocessing
-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

Level 0 data

Raw Data

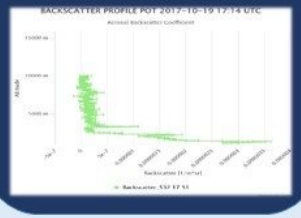
Level 1 data

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



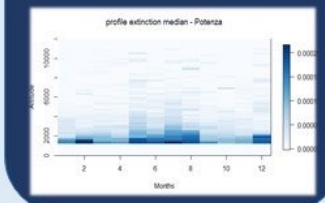
Level 2 data

Fully Quality Assured Aerosol optical and microphysical vertical profiles



Level 3 data

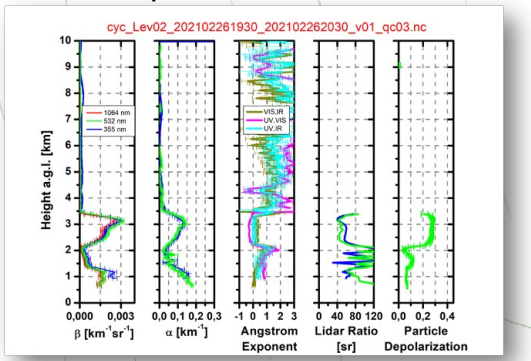
Statistical Analysis (e.g. seasonality, annuality) of Aerosol Optical Parameters



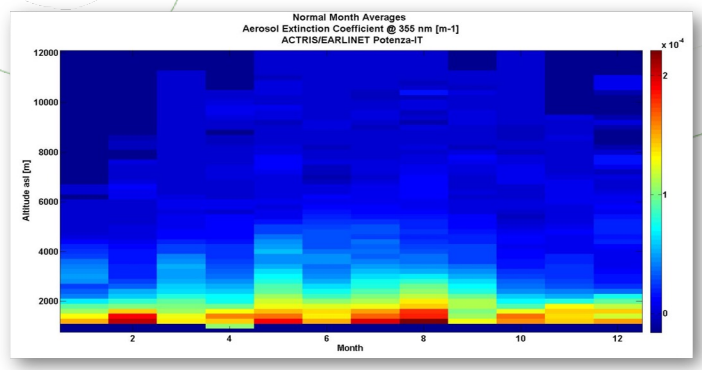
ARES Data

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

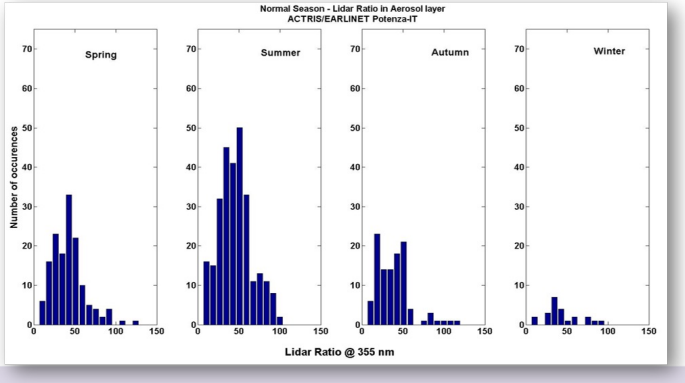
Aerosol Optical Profile Products



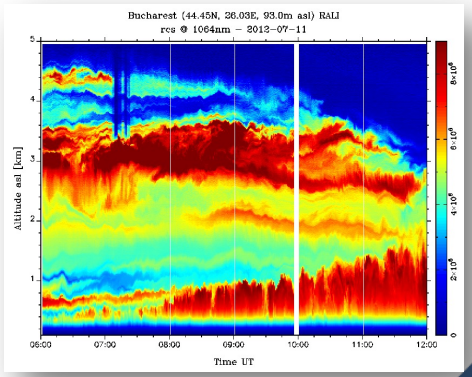
Level3: Aerosol Extinction Coefficient

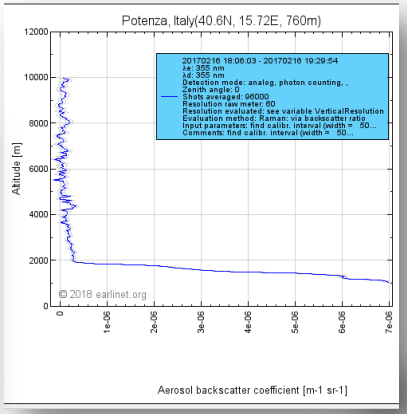


Level3: Lidar Ratio in Aerosol layer



ARES Data Level Structure





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

Pre-processed signals

High Resolution products

High quality profiles – Multi-wavelength

Layering /Typing products (under dev.)

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

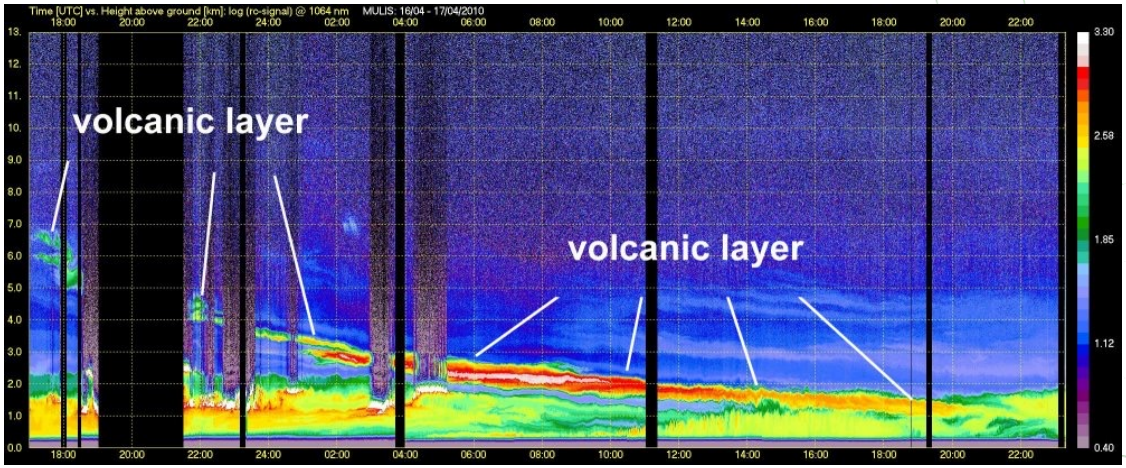
EARLINET-AERONET combined data internally available

Synthesis products

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

Extreme events characterization

Eyjafjallajökull eruption observation over Payerne

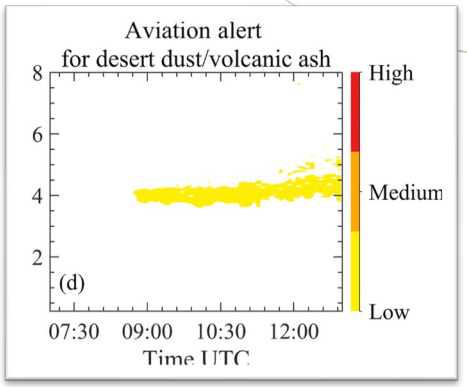


- Daily report to VAAC
- Database released
- Modification processes over Europe

Pappalardo et al., ACP, 2014

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

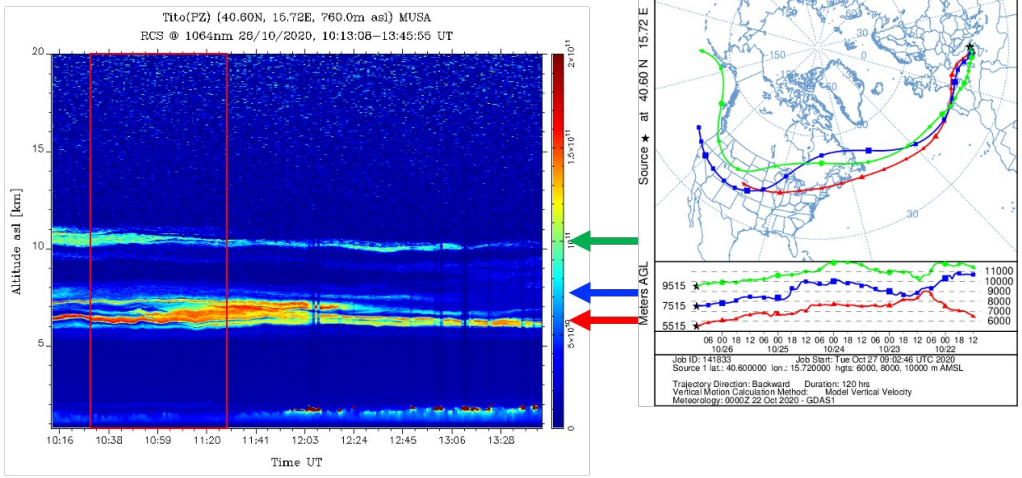
Hazardous events monitoring and impact mitigations

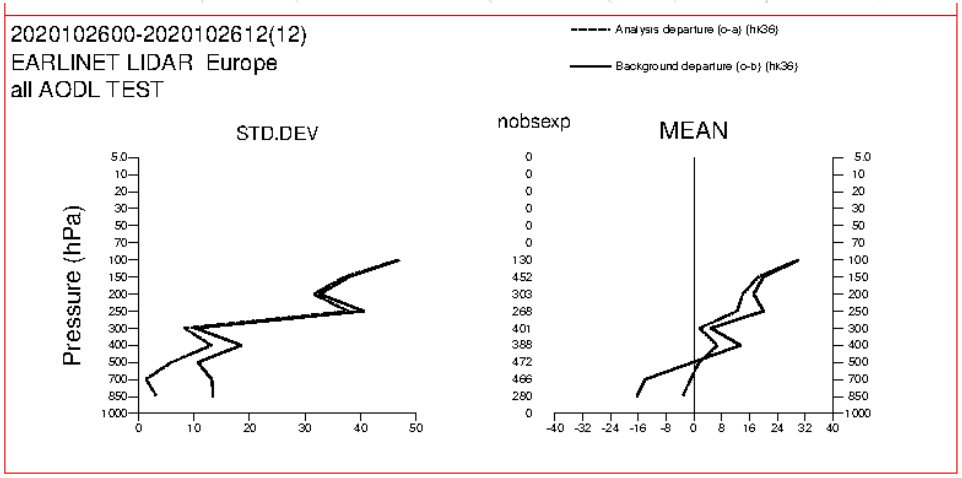


NRT provision

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 visibile in the vertical profiles.

Model improvement through assimilation