RI-URBANS:
Service Tools - Profiling

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European Commission | HORIZON 2020

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Service Tools - Profiling

Boundary level height ST7

It guides on how to characterise the above parameters of the ABL & dynamics using automatic lidars and ceilometers (ALC), and Doppler wind lidars (DWL).

Aerosol Profiles ST8

It provides details about QA/QC procedures and availability and accessibility of aerosol optical properties, from NRT provision to climatology + aerosol typing profiles.

Commercial aircrafts profiles ST9

It provides details on QA/QC and availability and accessibility of aerosol and trace gases profiles at worldwide airports.

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Atmospheric Boundary Layer (ABL) Dynamics

Entry of air with different composition
(pollutants, moisture, temperature)
- Fresh air from free atmosphere
- Secondary pollutants from residual layer
- Transported pollutants from elevated layers (e.g. dust, smoke, etc)

Entrainment

Current mixing processes
- Vertical exchange
- Horizontal exchange
- Layer growth
- Deposition

Vertical mixing

Stratification
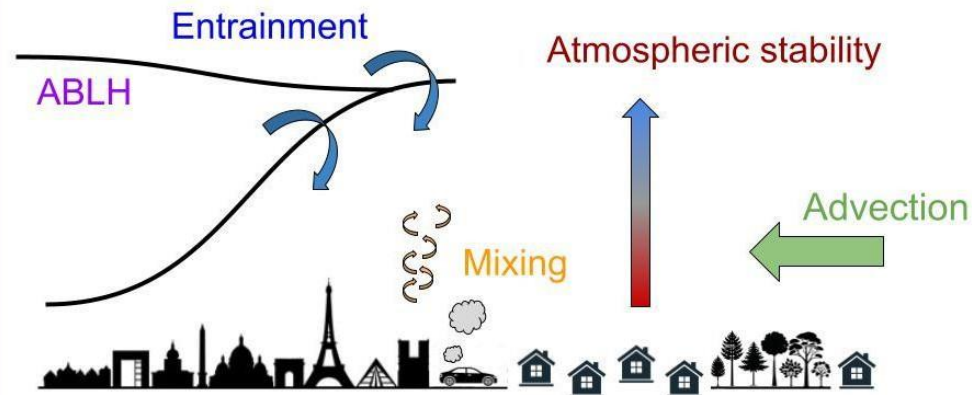- Synoptic conditions + surface-processes
- Gradients in temperature, wind, moisture

Atmospheric stability

Layer heights
- Determine volume for pollution dispersion
- Especially critical for shallow heights

→ indicator resulting from mixing, buoyancy, entrainment, advection

ABL Height

Transport
- Exchange rural - urban
- Exchange intra-urban
- "Ventilation corridors" along zones of low roughness

Advection

European Commission

HORIZON 2020

Italian National Research Council

cnrs

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Indicators of ABL Dynamics

Layer detection:

Automatic lidars & ceilometers (ALC)
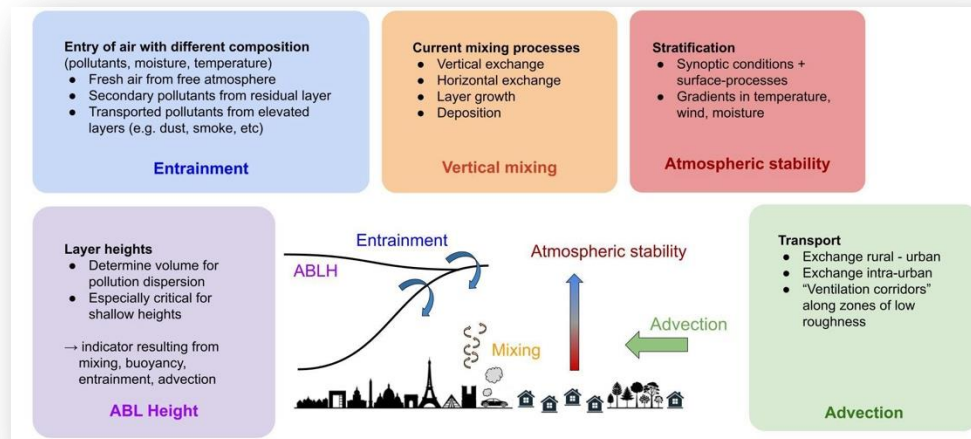
Doppler Wind Lidar (DWL)

Stability and mixing:

Doppler Wind Lidar (DWL)

Micro-wave radiometer (MWR)

Advection:

DWL, ALC

Layer detection and heights

AERIS ABL testbed (ACTRIS, E-PROFILE, ICOS, IPSL)

- **Automatic lidars & ceilometer (ALC),** different sensor types

- Tailored layer tracking (Kotthaus et al. 2020)
  - Calibration, corrections (e.g. overlap), quality control
  - Operational for high-SNR ALC (Vaisala CL61, Lufft CHM15k)
  - Further development required for low-SNR data

- Annual files & quicklooks distributed via AERIS database

□ Ready for upscaling Currently work in progress into
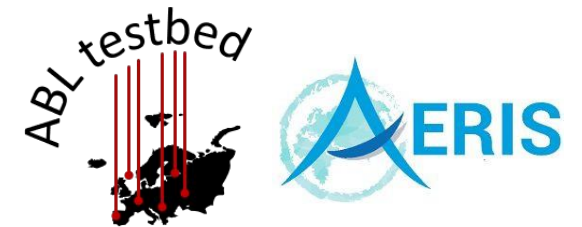
ALC in urban setting

@Haeffelin

Wind and turbulence profiles

- **Doppler Wind Lidar** processing at ACTRIS Cloud Remote Sensing data centre [Cloudnet data portal](#)

- Different sensor types (Vaisala, HALO Photonics, ...)

- Optimisation of automatic processing procedures ongoing (CCRES)
  - Vertical wind profiles from DBS & VAD scan modes
  - Turbulence profiles (TKE, ε, σ_w)
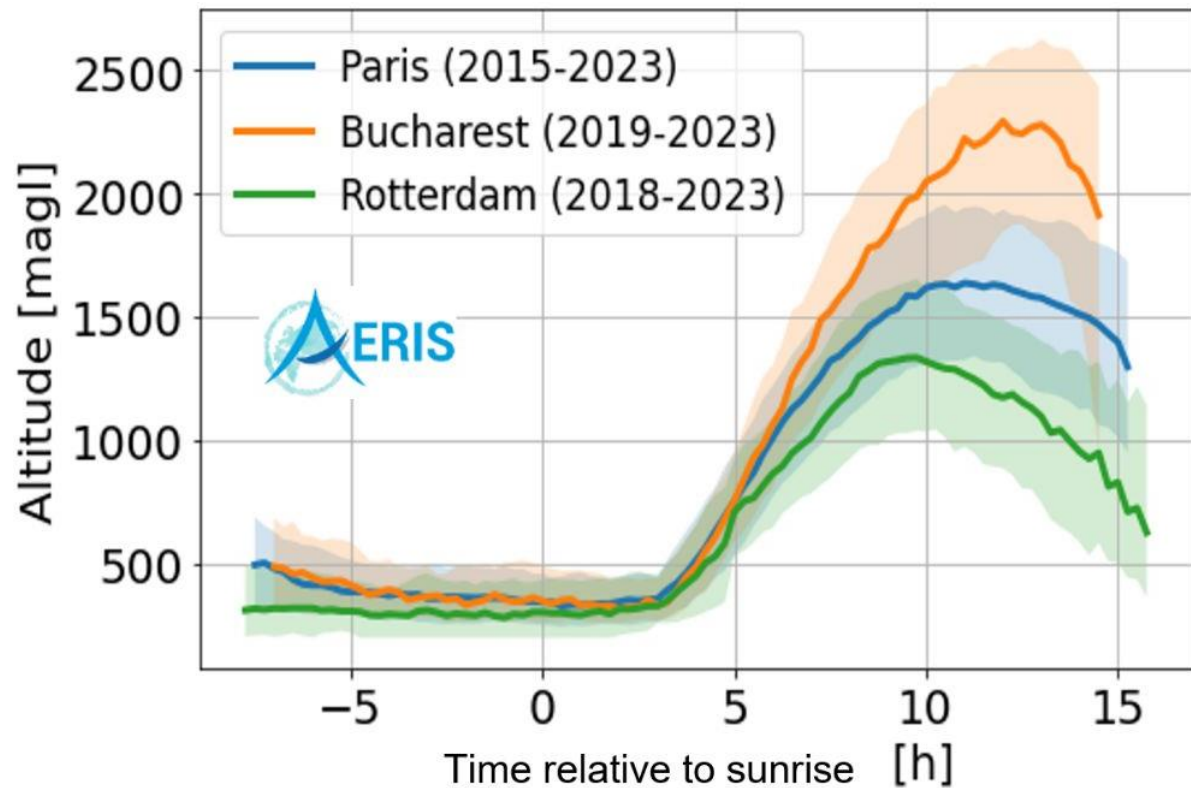
- System for monitoring of housekeeping data

Céspedes (2024), PhD thesis
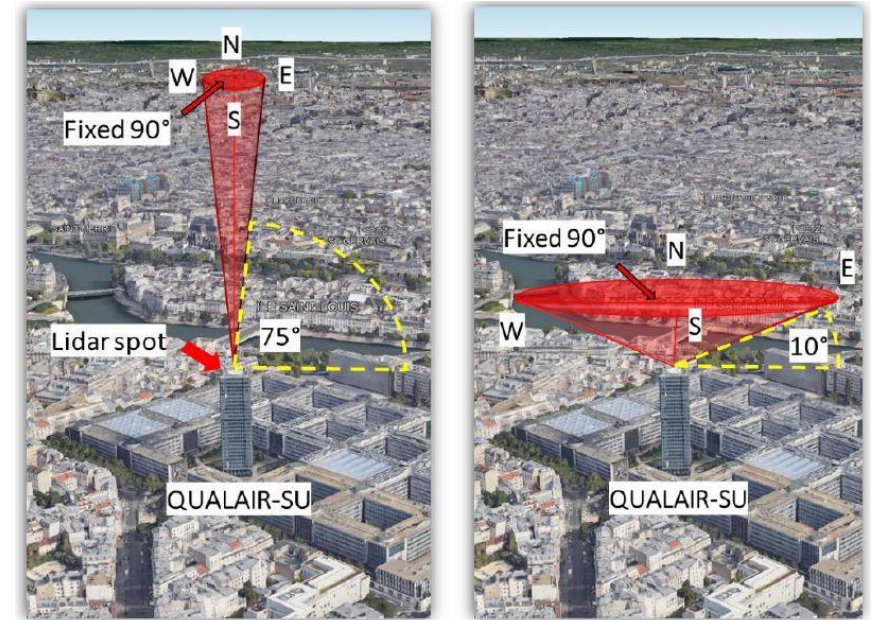
Shallow-DBS to monitor wind profile in blind zone of standard DBS

Scan-strategy guidelines
- Revisions ongoing
- Instrument specific
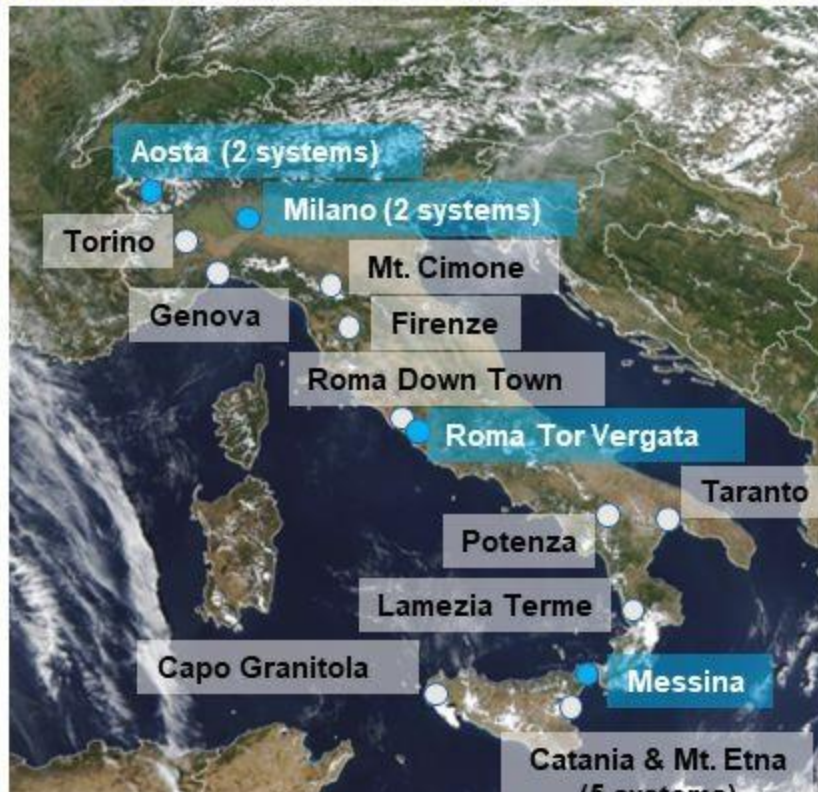- Requirements for urban settings

Mixed Layer Height
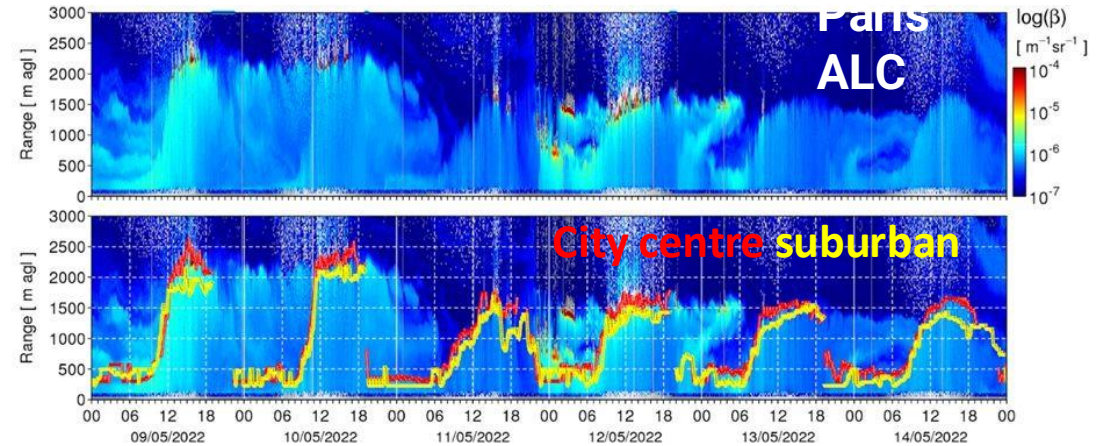
AERIS ABL testbed:
- Multi-year data
- Relevant variations across European scale
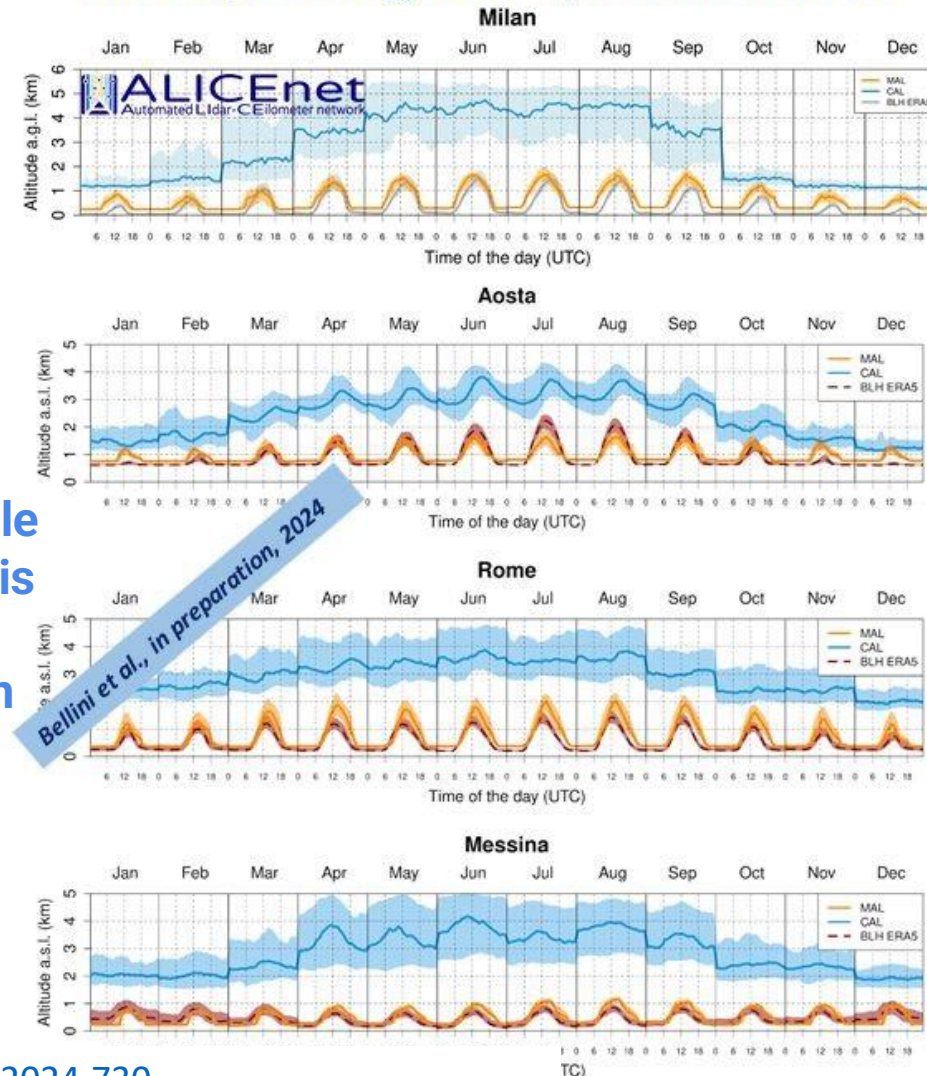- Spatial differences across urban area being examined

Long-term analysis

example analysis in 4 Italian sites

PROCESSING TOOL: Bellini et al., (2024), https://doi.org/10.5194/egusphere-2024-730
LONG TERM ANALYSIS: Bellini et al. (2025), https://doi.org/10.3390/rs17030372

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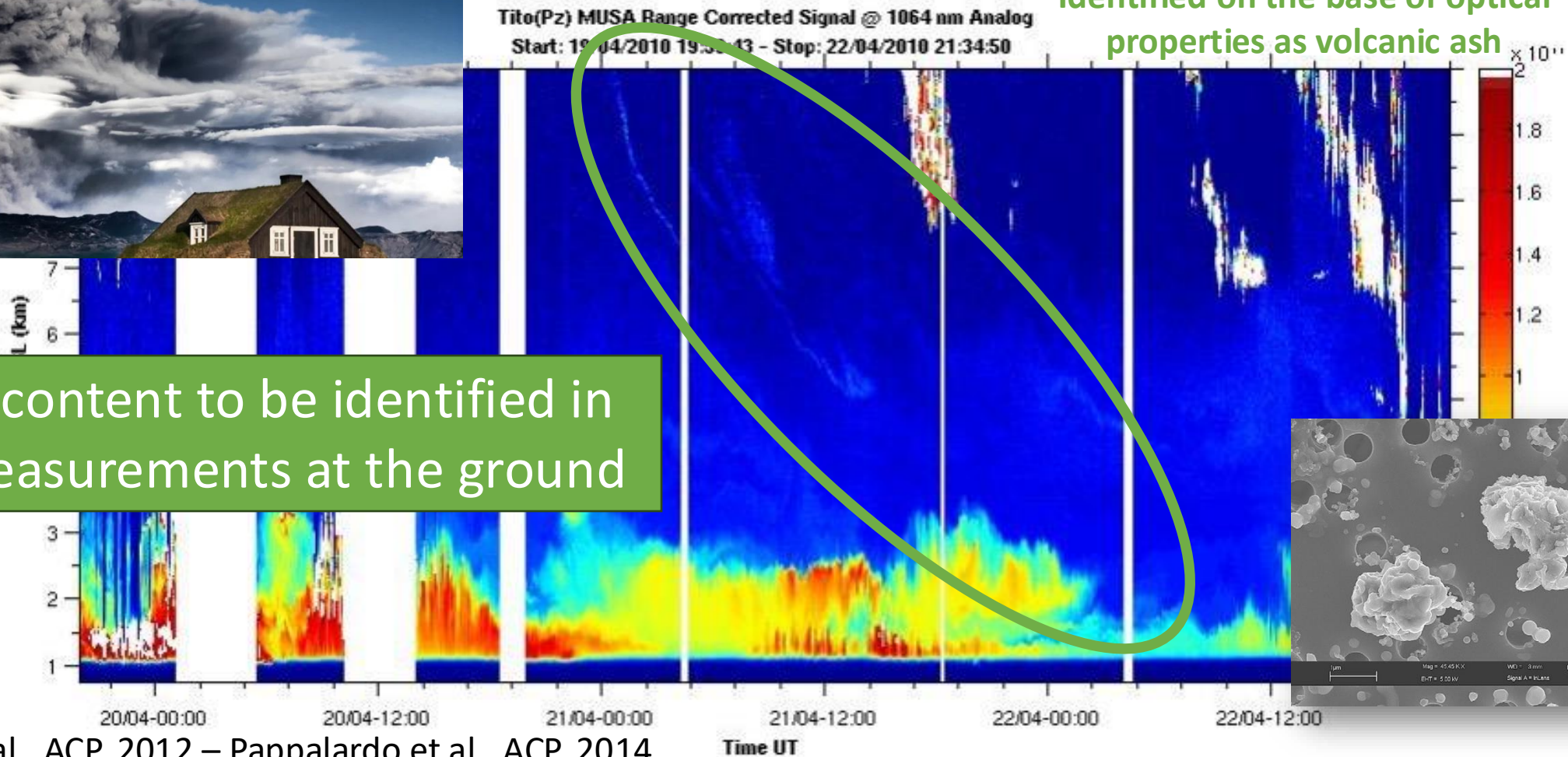
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Long Range Transported Aerosol at ground

Identified on the base of optical properties as volcanic ash

Small content to be identified in the measurements at the ground

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

Lettino et al., Atm Env, 2012

Standardization status and data availability

- High level of standardization through SOPs, QA and QC procedures thanks to ACTRIS CF and DC

- All the data, products, software and tools are **free and openly available**

ACTRIS standardized Aerosol Profiling Tools

- Aerosol optical profiles:
  53 stations over 22 Countries, (15 providing data in NRT),
  database start since 2000
  https://data.actris.eu or https://data.earlinet.org

- Aerosol typing profiles:
  26 sites -2015-2023
  https://commons.datacite.org/doi.org/10.57837/cnr-imaa/ares/natali-earlinet-typing-2015_2023

- Aerosol climatological profiles:
  33 sites -2000-2019
  https://commons.datacite.org/doi.org/10.57837/cnr-imaa/ares/actris-earlinet/level3/climatological/2000_2019/all

ST – Aerosol Optical properties
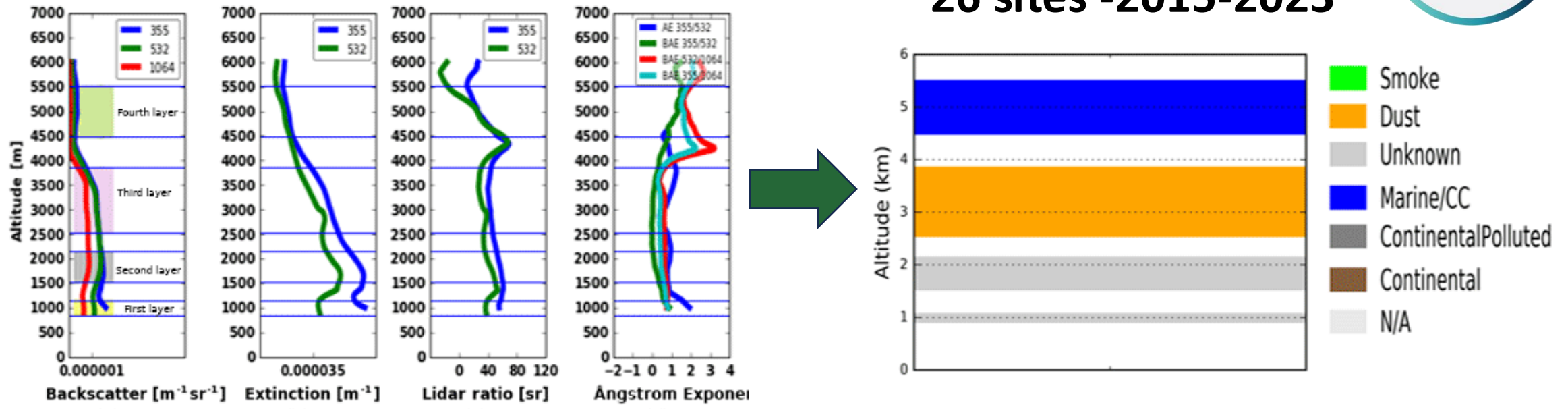
https://data.earlinet.org/earlinet/

- Aerosol optical properties profiles at different wavelength (backscatter, extinction, lidar ratio and depolarization) *available through visual interface*   <u>NRT provision system</u>

- Those + all the pre-processed data available with API system
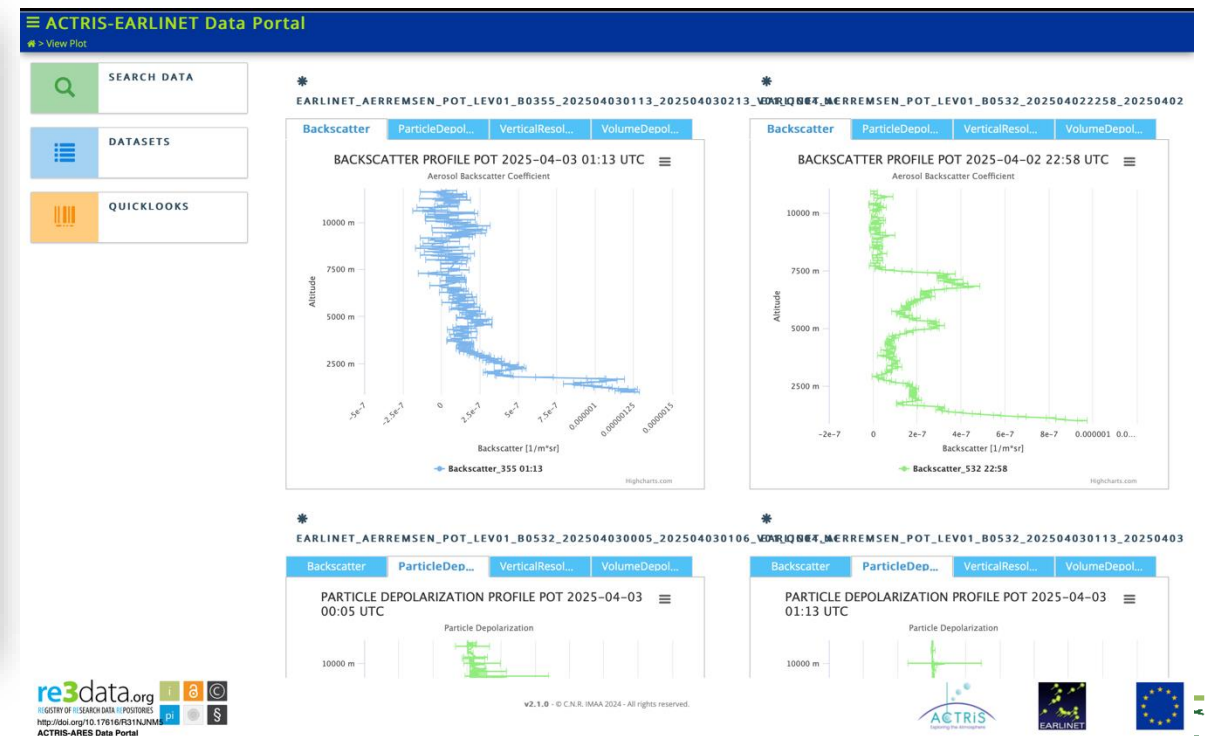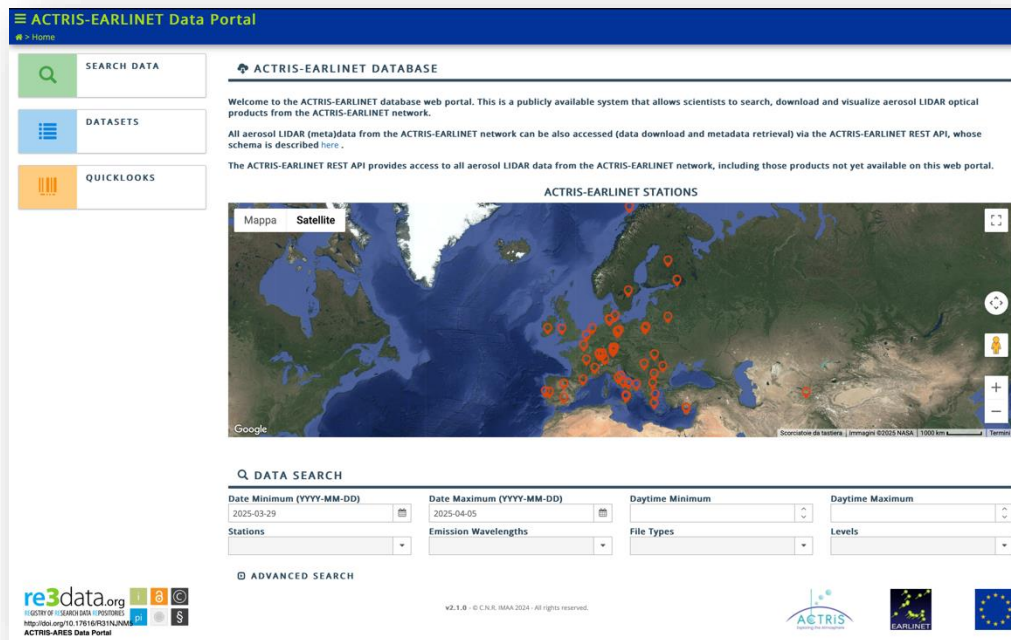
ST – Aerosol typing

26 sites -2015-2023

At lowest part of the atmosphere(<3km): local aerosol sources are the main contributors.
Continental aerosol is predominant in Central Europe, West and Central Mediterranean.
Smoke is in East and West Europe, and East Mediterranean,
Continental polluted is in Central Mediterranean and North Europe.

ST Climatological products

33 sites -2000-2019

More pronounced trapping of aerosol closer to the surface at big cities locations

Examples of **cities close to the sea**

Naples and Athens
big metropolitan areas
vs
Lecce (IT) <100 k inhabitants

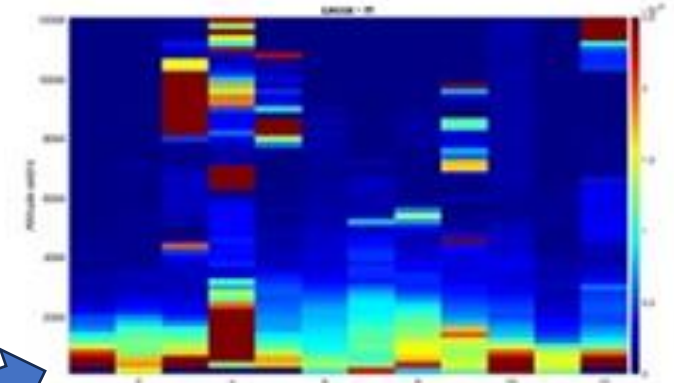*Climatological monthly averages of the aerosol backscatter profiles at 532 nm*
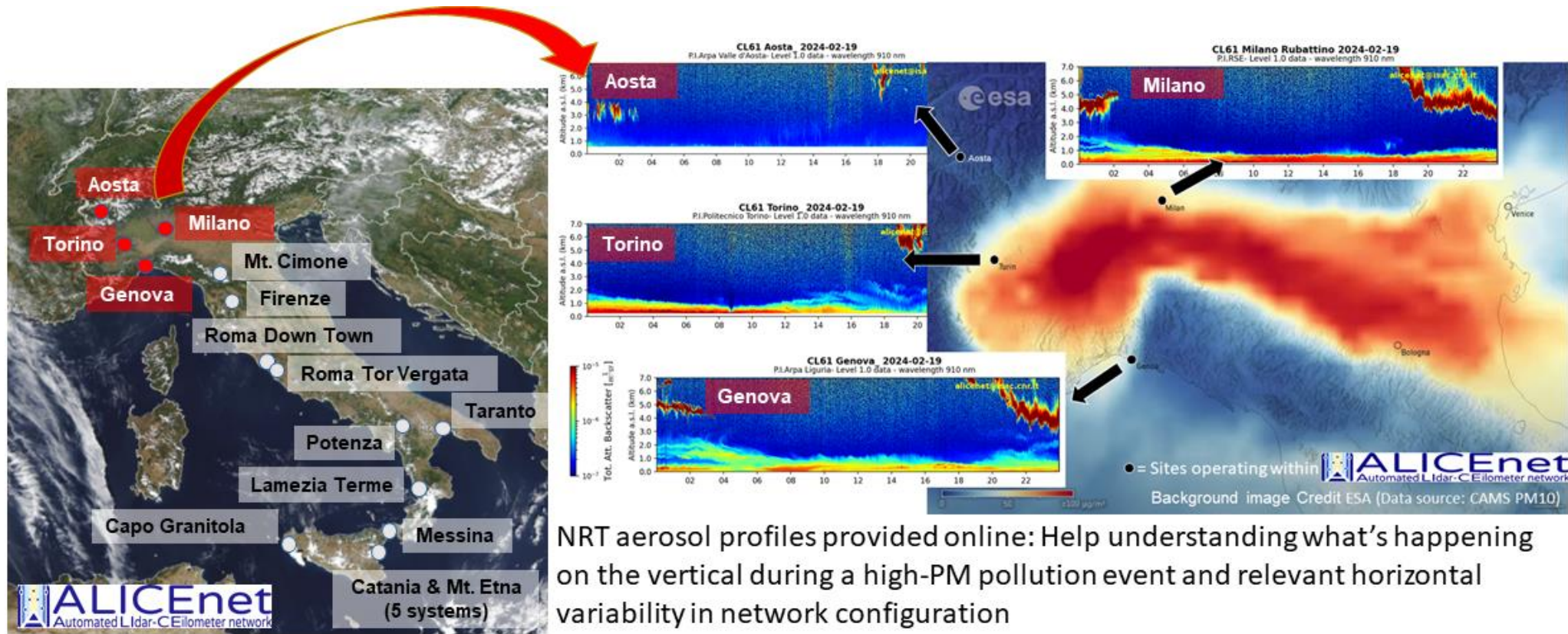

Naples
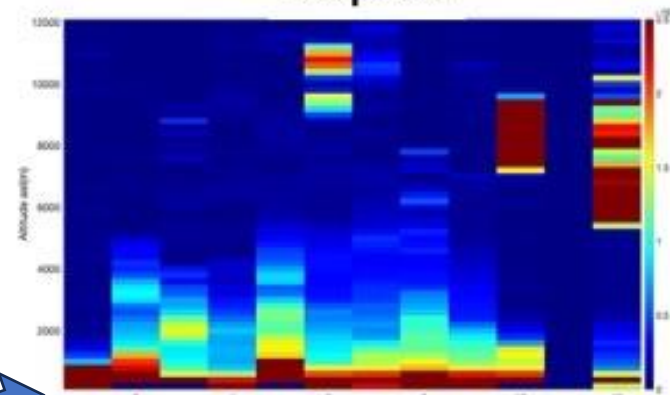
Athens
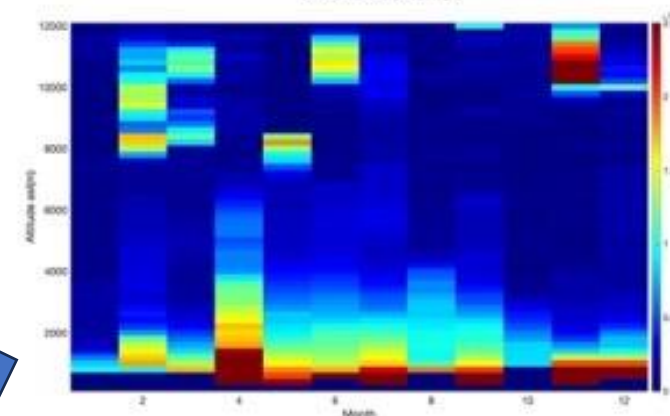
Lecce

Close to the surface more yellow than red (lower amount of aerosol) and the area homogeneous in color is wider

Experimental tool from ceilometers

NRT aerosol profiles provided online: Help understanding what's happening on the vertical during a high-PM pollution event and relevant horizontal variability in network configuration

Thanks to Stakeholder engagement efforts, some ALC systems contributing to ALICENET are already run by or in collaboration with Italian regional EPAs AQMN (e.g. ARPA Valle d'Aosta, ARPA Lazio, ARPA Liguria, ARPA Puglia, ARPA Sicilia)   *Bellini et al., 2024*

Presentation-> Deimoz later today

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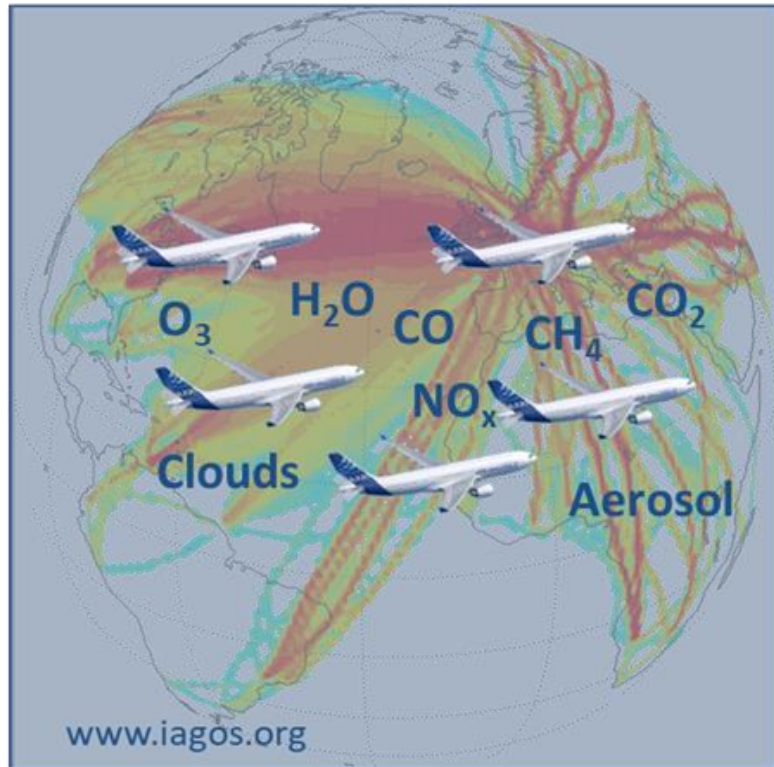
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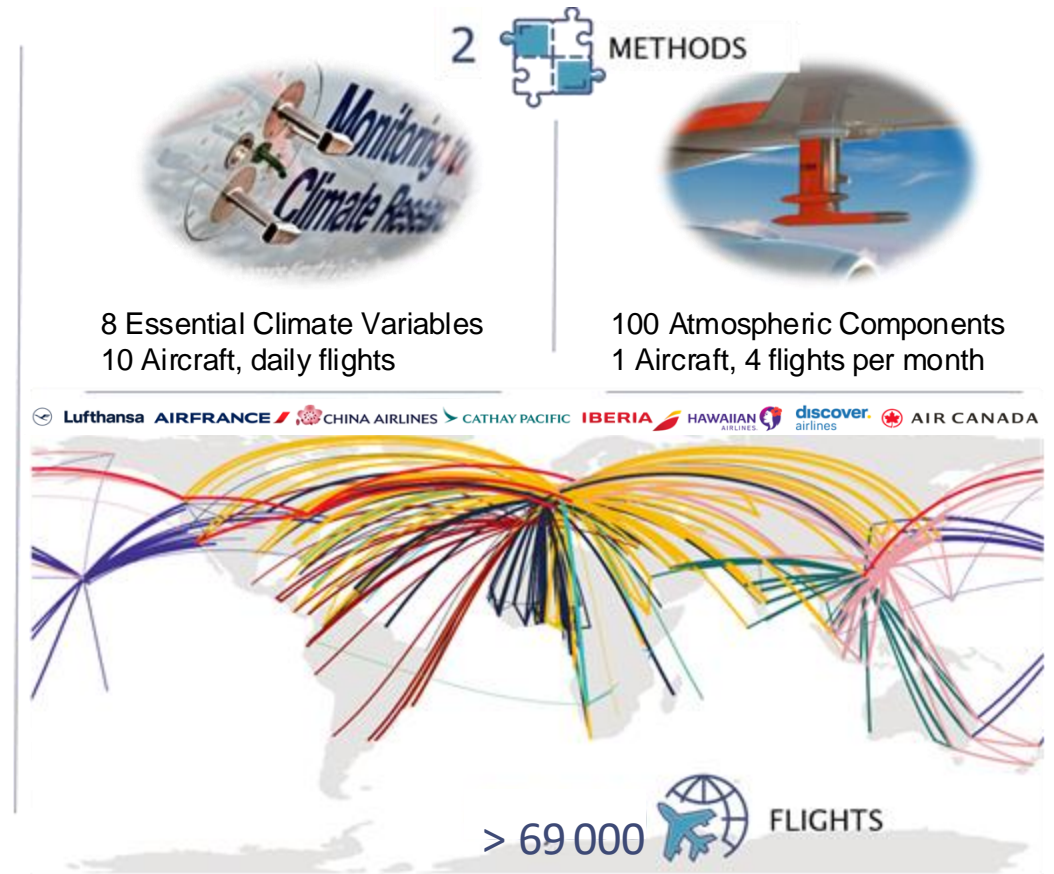
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IAGOS: European Research Infrastructure for monitoring climate and air quality using commercial aircraft

Air Quality Observations on IAGOS
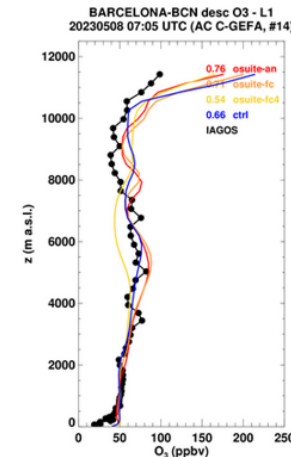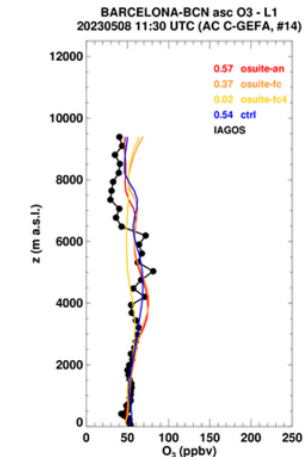
Visualisation Service for vertical profiles:

- Available at www.iagos.org/products

- For CAMS global and regional scales

- Subset of profiles over the RI-URBANS pilot cities is accessible under the category RI-URBANS:

  - Currently: Amsterdam, **Milano**, Barcelona, Paris, and Zurich.

- NRT: CO, O_3, and H_2O

- In preparation: L1/L2 NO, NO_2, and NO_x

Thank you!