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The Work Package 8.3 - Crop, Plants and Pests VRE (CPP VRE) is part of WP 8 (Virtual Research Environments and Cross-disciplinary Activities) of Italian Integrated Environmental Research Infrastructures System (ITINERIS). ITINERIS is a project funded by EU - Next Generation EU PNRR- Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realization of an integrated system of research and innovation infrastructures".

### Main goals of WP 8.3:

- Make accessible in ITINERIS an array of cross-platform modelling solutions, data transformation tools, and cloud hosted computational facilities to contribute to crop production, plant phenology, pest and disease spread, and cropping system.
- In accordance with ITINERIS specifications, develop or adapt well-established process-based models for (1) crop production, (2) water use, (3) plant phenology, (4) pest and disease spread, (5) pathogen dynamics, (5) cropping system management, and advanced statistical methods for (6) time series analysis and (7) image classification.
- ® Provide clear and easy-to-understand usage documentation through examples in Jupyter notebook.



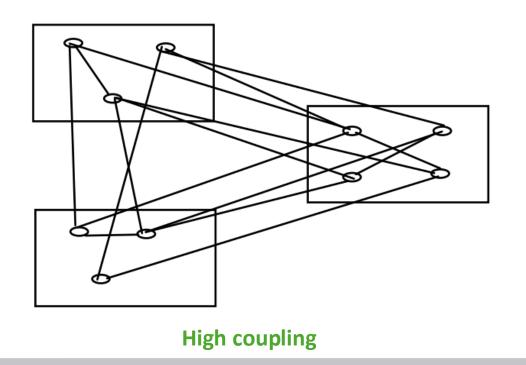
The Agro-Ecological Modelling platform development for ITINERIS considered the following software engineering aspects:

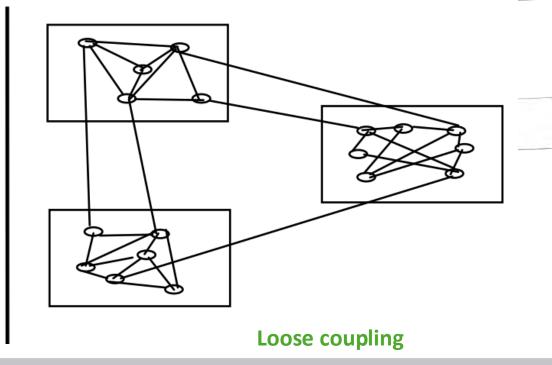
- ® Reusability: code reuse refers to the practice of leveraging existing code for new functionalities in software development. This reduces errors and bugs (i.e., components are already tested and debugged), saves time and resources in components implementation, and so on.
- Maintainability: the ease with which a software system or component can be modified to correct faults, improve performance or other attributes, or adapt to a changed environment (IEEE standards).
- Portability: software portability is the possibility to use the same software in different environments.
- Interoperability: capability of different solutions to communicate with one another freely and easily.
- Performance (or Efficiency): performance measures how effective is a software system with respect to time constraints and allocation of resources.
- Usability: software usability refers to the controlled element of user experience design that makes sure that users do not face problems when using a website's user interface or product.
- Understandability: understandability is the concept that a system should be presented so that a researcher can easily comprehend it. The more understandable a system is, the easier it will be for researchers to use it in a predictable and correct manner.



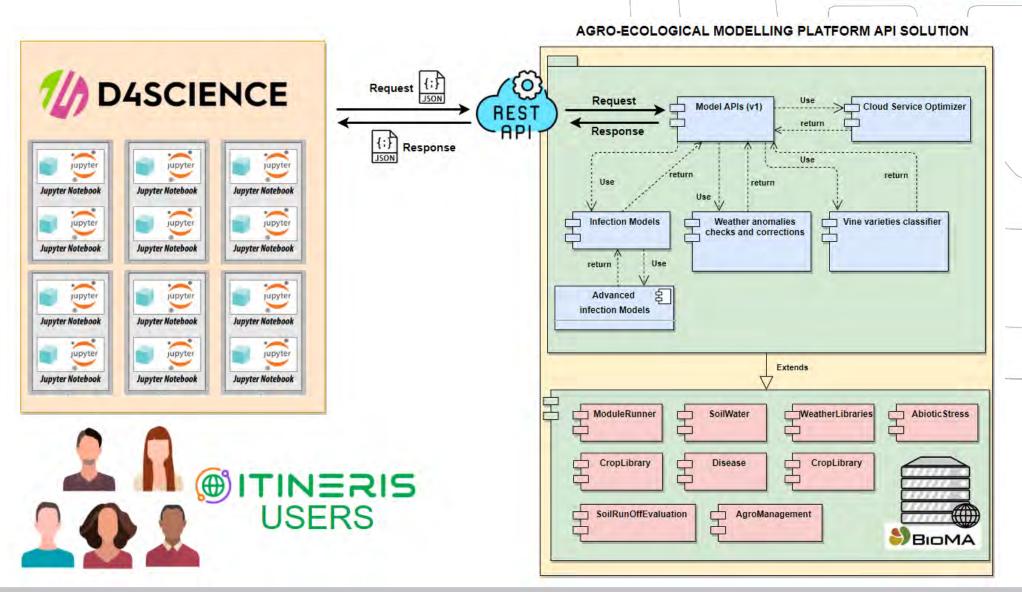


Modularity in software engineering refers to the design approach that emphasises the separation of concerns, where a complex software system is divided into smaller, loosely coupled modules.











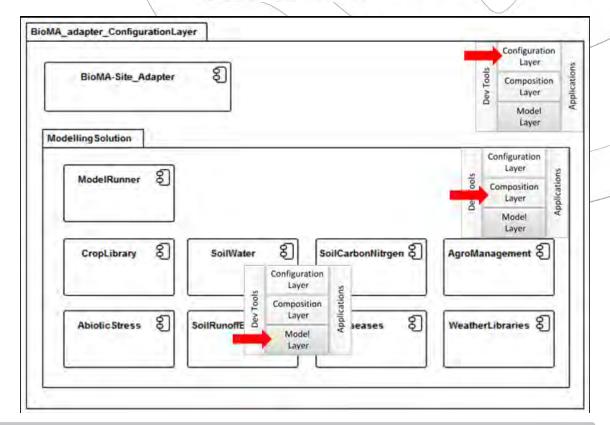
### **Reusability -> BioMA**

The domain model of the Agro-Ecological Modelling platform is a cloud extension of **BioMA**, specially made for the ITINERIS project.

**BioMA** is a modelling framework composed of models and applications designed for running, calibrating, and improving biophysical and crop growth models. Biophysical models are algorithms to simulate a part of the biophysical system. Such algorithms can be coded into discrete software components.

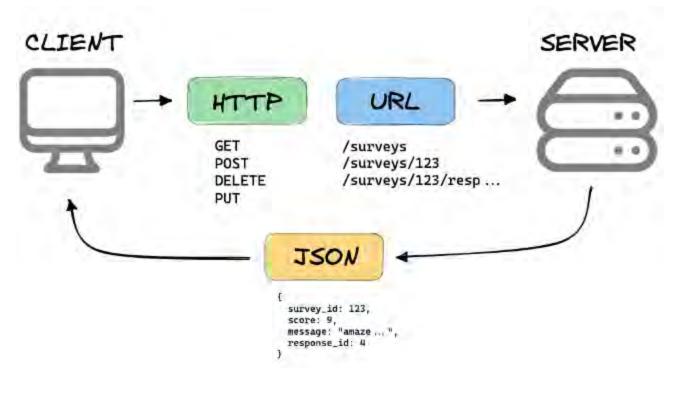
The **BioMA** modelling framework is based on *independent components*, for both modelling solutions and the graphical user interface. The framework also includes integrated tools to support the calibration of the models, to run the simulations at grid level, and to visualize the results. All services of the extended version of BioMA for Agro-Ecological Modelling platform are exposed by RESTful API.





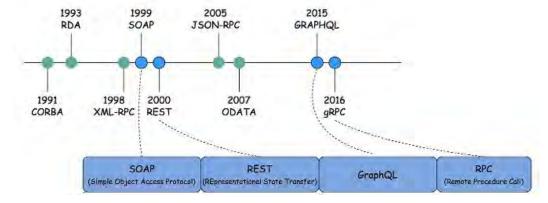


**Interoperability** and **Usability** -> API RESTFull



A **RESTful** (*REpresentational State Transfer*) **API** (*Application Programming Interface*) is the most common standard used between Clients (a researcher or application) who want to access information from the web from Servers (i.e., CPP VRE) who have access to that information.

The ideas in REST aim to be simple and to decouple the API from the underlying services that serve the API. It uses a request-response model and is stateless, as all the information necessary to do something is contained within the request.





### **CPP VRE API endpoints**

- Infections Models: this endpoint incorporates different models of phytopathology infection in agricultural settings. Agro-Ecological Modelling platform hosts a growing collection of plant infection models (e.g., Oidio, Peronospora, and so on) tuned to perform well over the Italian territory.
- Advanced Infections Models: this endpoint includes a new set of infection models including crop phenology.
- Wine varieties classifier: a computer vision model to identify grapevine variety from leaf images. Leaf images must be full frontal and in good light conditions. It identifies 27 distinct varieties from the CREA (Council for Agricultural Research and Economics) collection
- Weather Anomalies Check and Corrections: service to check anomalies in a weather data series and correct them according to a set of rules.
- © Cloud Service Optimizer: service to run optimization jobs over APIs exposed through the platform. Its main purpose is to allow model calibration.
- Model APOs-v1: APIs to configure and run model executions.









### THANKS!













### **AERO VRE**

2nd ITINERIS General Project Meeting Rome, July 9th - 10th, 2024

Emilio Lapenna, Michail Mytilinaios, Benedetto De Rosa, Nikolaos Papagiannopoulos, Ermann Ripepi, Lucia Mona CNR-IMAA









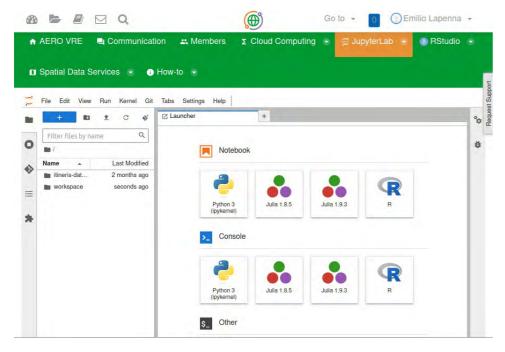


### Specific details of our VRE designed for atmosphere domain

**#ITINERIS** 

Computing resource information: 4 vCPUs + 16 GB RAM (possible upgrade to 8 vCPUs + 32 GB), disk space > 100 GB

JupyterLab Python 3.10 and RStudio plus preinstalled modules (pandas, scipy, matplotlib, netCDF4, h5netcdf, etc), other services available;





https://itineris.d4science.org





### Main advantages of a VRE:

- Preinstalled complete environment which free the user from installation troubles and issues;
- The environment is designed for scientific data analysis and computation as "turn-key";
- The environment can be exploited via browser so does not require significant computation power by user systems, it is accessible worldwide and h24;
- The environment is smart and can be extended or integrated with new technologies or resources;



#### Present structure of VRE

The VRE facilities are divided in two main branches, the Desert Dust and the Aerosol Typing;

**VRE** 

**AEROSOL TYPING** 

the future;

Green sections have been

have been done on VRE;

implemented and some initial tests

Gray section will be implemented in



SINGLE CASE

CLIMATOLOGICAL

**DESERT DUST** 



DOD (Dust Optical Depth)

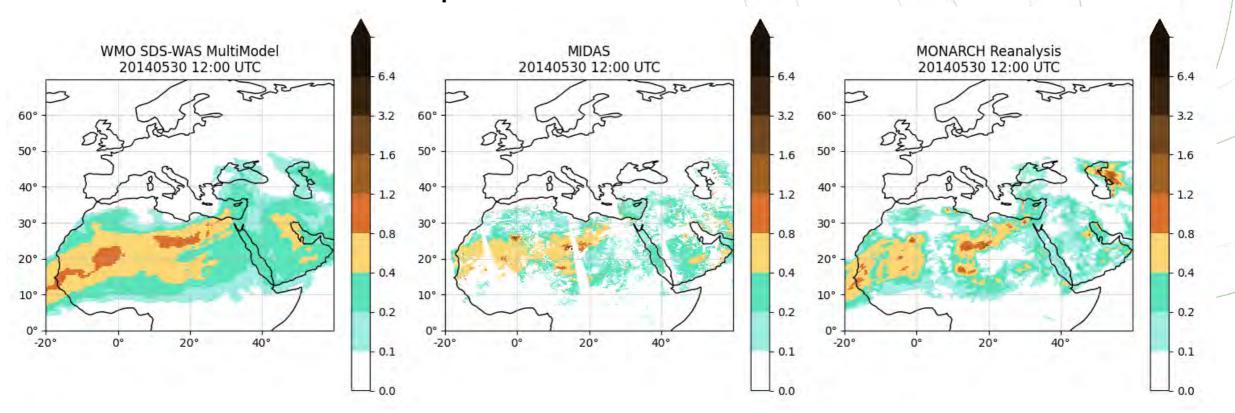
**PROFILES** 



(#) ITINERIS

Case 1: code refactoring and porting from MATLAB

### WMO SDS-WAS Multi-Model dust product



Data from WMO SDS-WAS (<a href="https://sds-was.aemet.es">https://sds-was.aemet.es</a>), MIDAS (Gkikas et al. AMT 2021) and MONARCH Reanalysis (Di Tomaso et al. ESSD 2022).

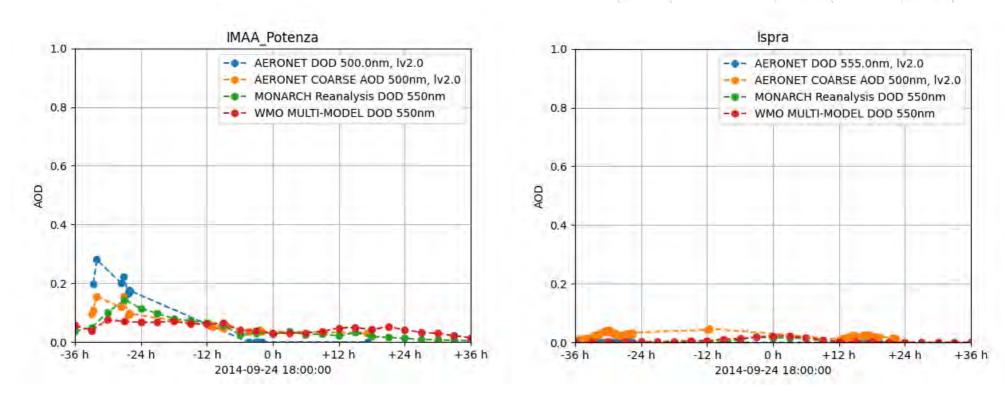
The users will be able to produce their own maps by choosing a **specific date** and adjusting **map boundaries**.

ITINERIS



#### Case 2: code refactoring and porting from MATLAB

### **Dust profiles by ACTRIS/EARLINET + AERONET DOD + MODEL DOD** (Potenza and Ispra sites)



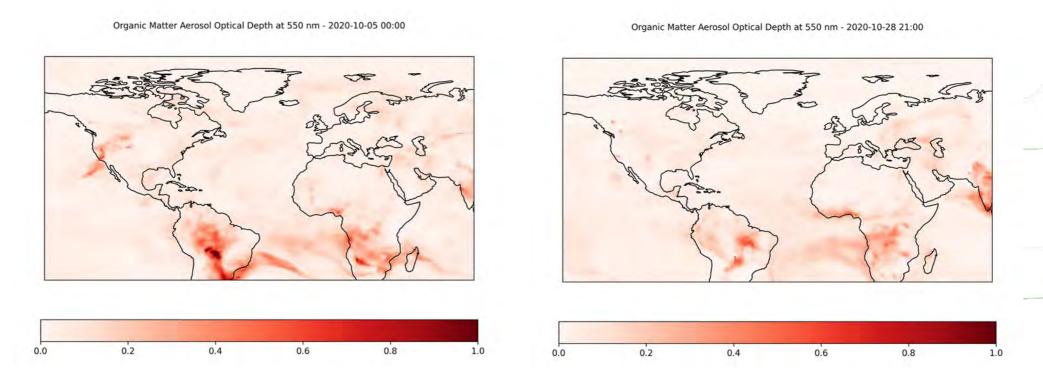
Data from station lidars together with photometric measurements can be used to generate vertical profiles and DOD over time, together are compared with data from WMO, MIDAS and MONARCH. The user will be able to produce high quality graphs for a **specific date and** *I* **or site**.

See the poster by Michail Mytilinaios for details on Dust Products!



### Case 3: code refactoring from Python

### **Aerosol Typing: Organic Matter AOD**



We use data from COPERNICUS satellite to generate global-scale high quality 2D maps for the time evolution of Organic Matter AOD. The users will be able to produce their own maps by choosing a **specific date** and adjusting **map boundaries**. The images show the evolution of OM AOD from October 9th to October 28th, 2020 with a temporal resolution of 3 hours.

### Present status of VRE



**DESERT DUST** 



DOD (Dust Optical Depth)

WMO SDS-WAS Multi-Model dust product

• Code porting (Python): **100**%

VRE deploy: ~ 30%

**PROFILES** 

Profiles by ACTRIS/EARLINET + DOD

Code porting (Python): 100%

VRE deploy: ~ 30%

**AEROSOL TYPING** 



**SINGLE CASE** 

**Aerosol Typing (OM AOD)** 

• Code porting (Python): **100**%

• VRE deploy: ~ **55**%

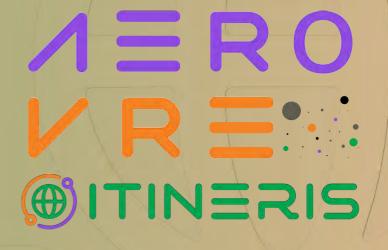
During porting activities to VRE the codes have been extended and enriched, some functionalities are being implemented or integrated to exploit available data and to fullfill complex user requests.



**2nd ITINERIS General Project Meeting** Rome, July 9th – 10th, 2024

Emilio Lapenna, Michail Mytilinaios, Benedetto De Rosa, Nikolaos Papagiannopoulos, Ermann Ripepi, Lucia Mona CNR-IMAA

### THANKS!













# CLIMA VRE: a first demonstrator, challenges and perspectives

Lagomarsino-Oneto D.<sup>1</sup>, Lira-Loarca A.<sup>2</sup>, Sciascia R.<sup>1</sup>, Corgnati L.P.<sup>1</sup>, Mantovani C.<sup>1</sup>, Besio G.<sup>2</sup>, Magaldi M.G.<sup>1</sup>

<sup>1</sup>National Research Council (CNR) – Institute of Marine Sciences (ISMAR), La Spezia, Italy, <sup>2</sup>University of Genoa (UNIGE), Department of Civil, Chemical and Environmental Engineering (DICCA), Genoa, Italy



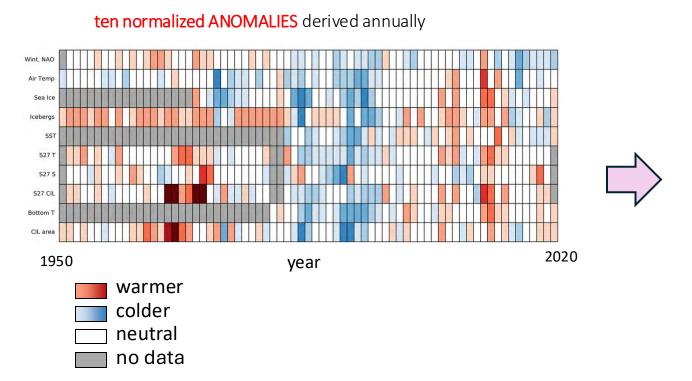


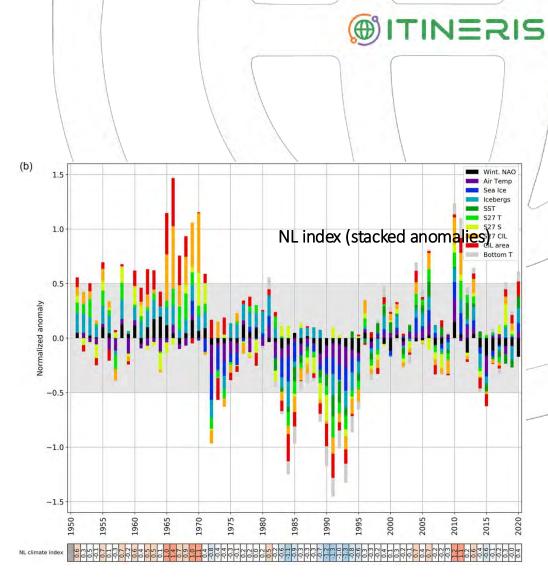




### An Example of Climate Indicator

taken from *Cyr e Galbrath, 2021 Earth System Science Data:* **Climate indicator for the Newfoundland and Labrador (NL) area** 



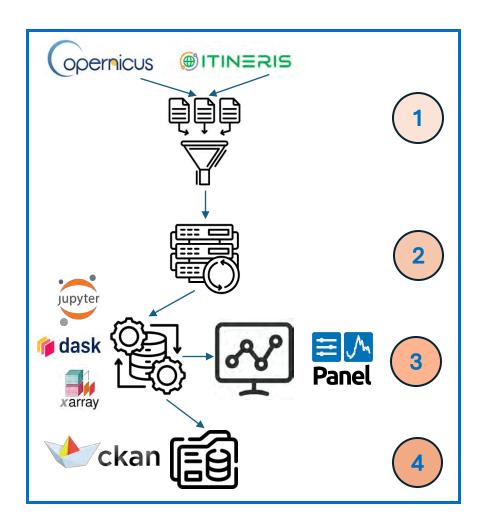


Link with ecosystem studies, stock assessments and models of marine resources!

Annual meeting - Rome - 9-10/07/2024

### A DEMONSTRATOR: SEA SURFACE TEMPERATURE



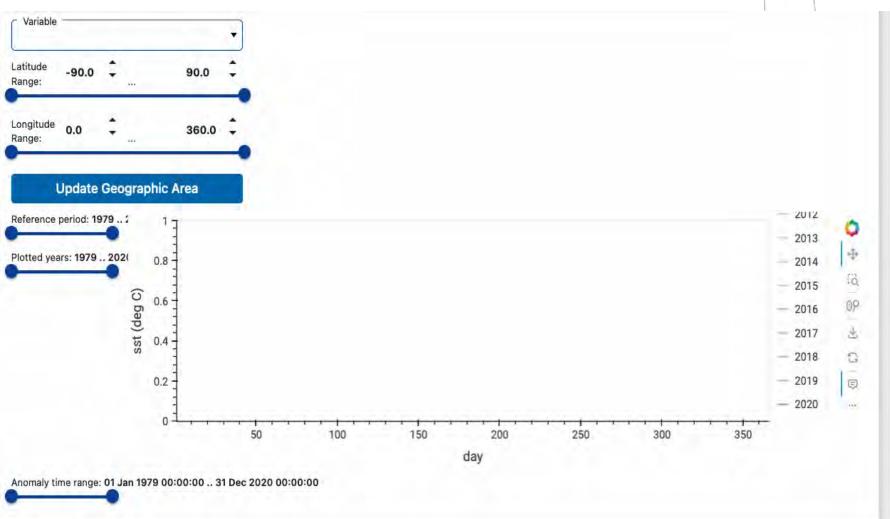


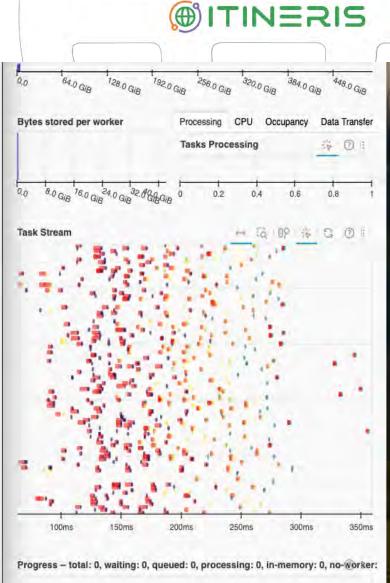
#### 1. DATA HARVESTING:

- SST from ERA5 daily dataset (global, 1979 today) from Azure Blob Storage (**CLOUD** storage designed for distributed access).
- Data from **COPERNICUS** (+ ITINERIS in near future)
- **HUGE DATASETS** will be peculiar of CLIMA VRE

- 2. DATA HARMONIZATION (format, variable names, spatio-temporal alignment)
- 3. DATA PROCESSING AND VISUALIZATION with interactive web application:
- We use python packages (xarray, dask) suited for DISTRIBUTED CALCULUS and BIG DATA.
- Interactive GUI developed
- 4. Publish in CLIMA VRE Indicator catalogue

### A FIRST DEMONSTRATOR: INTERACTIVE APP





### WHAT'S NEXT



Move the SST Demonstrator to CLIMA VRE

Implement the Data Harmonization step (necessary when multiple dataset are involved and when fresh data from the ITINERIS infrastructure will be available)

Develop a MULTI-MASK version of the APP that allows to compare and correlate time series from diverse geographic areas.



To join CLIMA VRE register at https://itineris.d4science.org/

### THANKS!











Essential Variables (EVs): a multipurpose tool for exploring ECVs and EBVs across multiple ecodomains studied by LTER italy network

Alessandro Oggioni, Paolo Tagliolato, Vladimiro Boselli e Giorgio Matteucci















### Objectives of EVs VRE



To ease EV-dataset-related activities for VRE members by means of an interactive R Shiny web app. Different users can find, select, visualize and share datasets related to Essential Variables (EVs).

To constitute a place where executable and documented scripts of analysis of EV data can be collected, written, shared and reused.



### Multi-purpose and multiple ecodomains



Go!



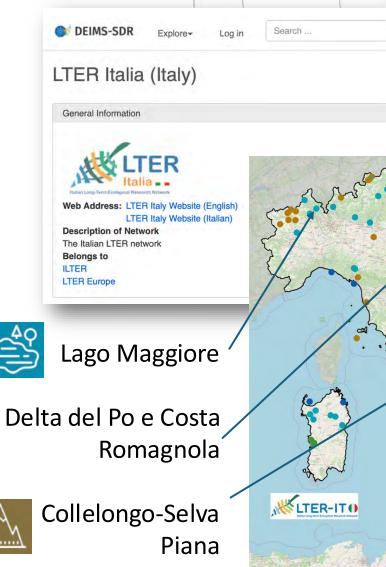
a single user profile



multi-user responses in the ShinyApp



scripts for people of different backgrounds



### EVs VRE components







datasets







★ ITINERIS EVs





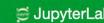


\* Administration



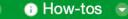
Communication

\* Members



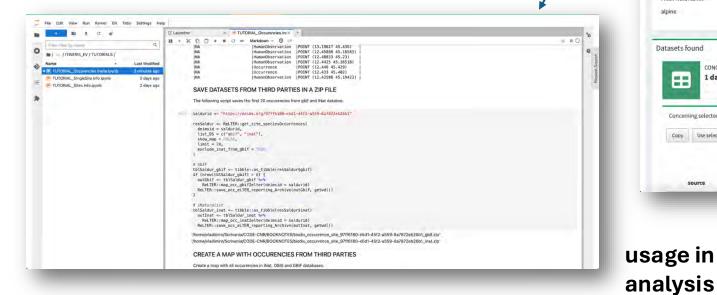


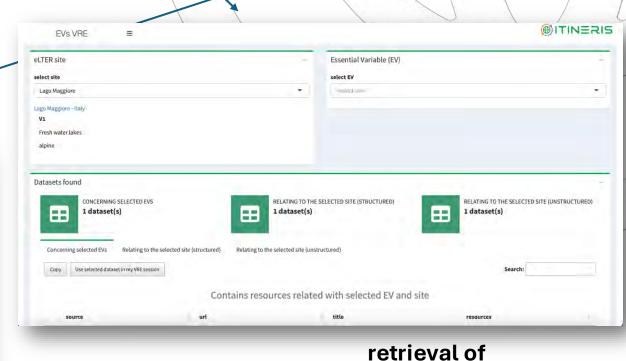




create an executable and documented script

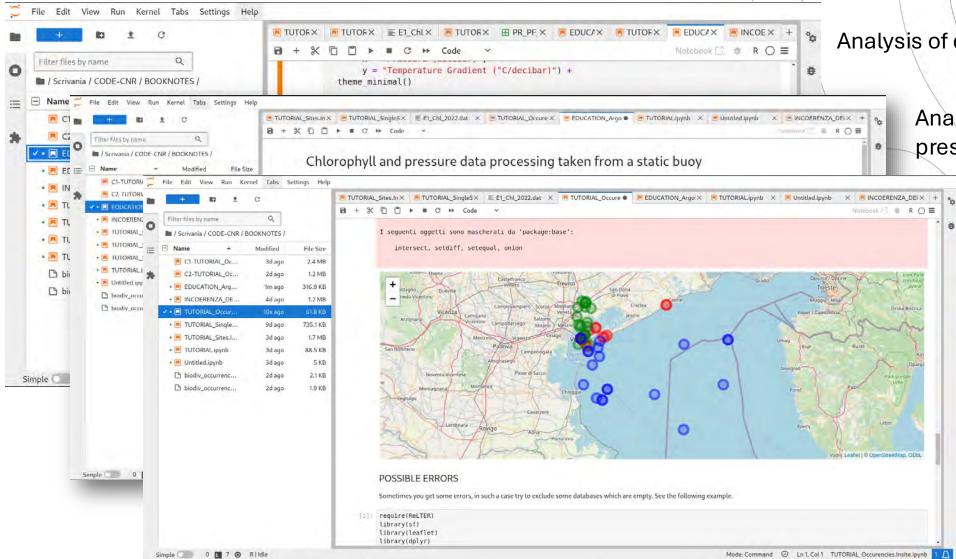
share or reuse this analysis or data product





### Jupiter notebooks





Analysis of dataset from



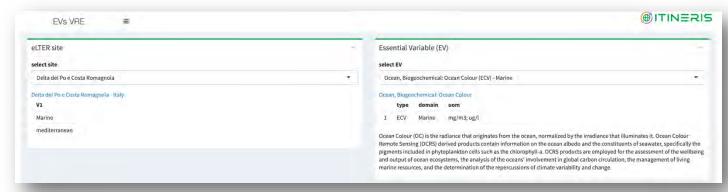
Analysis of chlorophyll and pressure from Relation

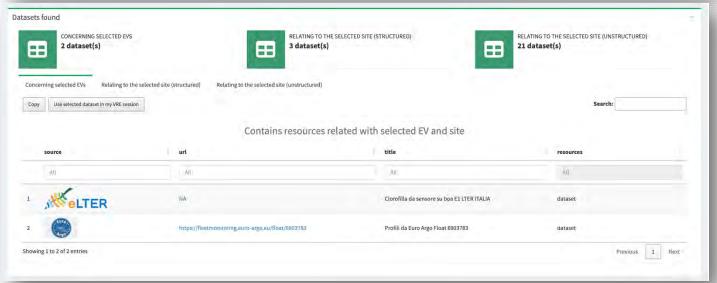
Analysis of specie occurrences from

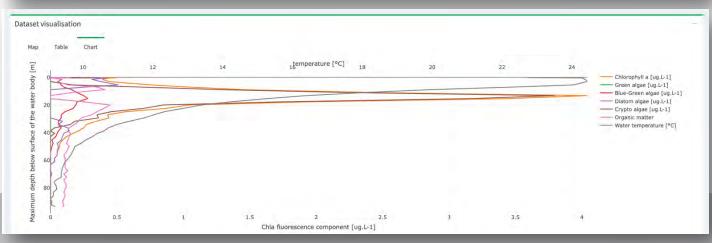












Shiny App



- Site and EV selection
- Datasets found
- Dataset visualization

### Next steps



### Enhance Shiny App Development:

- Add new repositories and implement additional functions for data harmonisation.
- Develop and document new executable analysis scripts.
- Involve colleagues from the eLTER infrastructure and other RI.

### Local and remote Integration:

- Align the local version of the Shiny App with the version in the Virtual Research Environment (VRE).
- Establish connections with data catalogues (GeoServer) and metadata systems (GeoNetwork) present in the VRE.

### Deliverable Preparation:

 Draft the deliverable, ensuring it comprehensively covers the progress and integration steps.



### THANKS!













The Ocean Sound data collection subsystem

Giorgio Riccobene INFN-LNS (WP5)









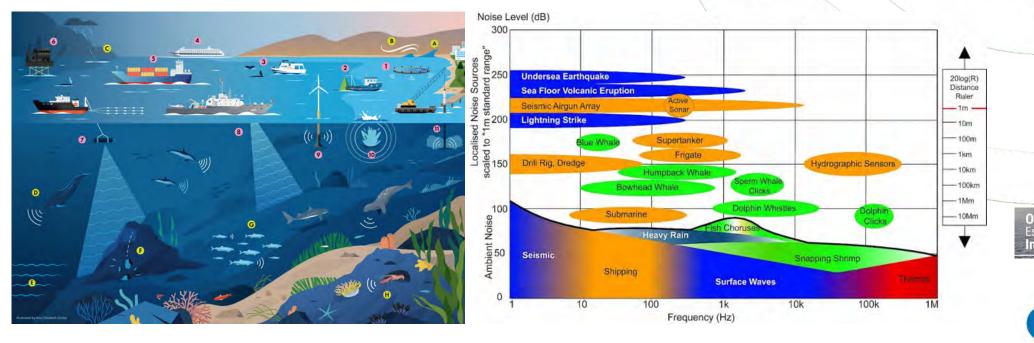


## Why is sound an important variable for observing the ocean at a global scale?



Ocean Sound carries information on several sources and processes in the ocean:

- Climate Change: wind, waves, rain; sound porpagation; ice-cap status
- Ocean Health: anthropogenic acoustic pollution, monitoring of soniferous species
- Safety, secutity: geophysical events (tsunamis eartquakes,..), illegal/banned activities, disasters,..



Attempts at international scale:

https://oceanexpert.org/downloadFile/45461

https://repository.oceanbestpractices.org/handle/11329/2405



The Global Ocean

# Integrate Ocean Sound in the IIOOS (Italian Integrated Ocean Observing System)



### **Implementation**



### Data collection

(raw data inhomegeneity):

Sensor type, depth, location, sensor calibration, sampling frequency, duration of acquisition, duration of experiment, time sampling,...

### Data Sharing/Exposure

Harmonise IR data sharing resources Avoid sharing of strategic/sensible data

### Data Analysis:

Definition of physical quantity, common/shared algorithms

### Data FAIRness

Metadata defintion for raw and analised data

Algorithms and codes for analysis should be shared over a project code sharing platform

# Integrate Ocean Sound in the IIOOS (Italian Integrated Ocean Observing System)



### **Implementation**

### Harmonise data harvesting strategy:

Record not less than 5 continuous minutes of data every hour during the experiment Use calibrated sensors (uncalibrated sensors should be used for a limited subset of analyses)

### Definition of physical quantity to be derived from raw data

**Sound Pressure Level** (to start with)

### Path for data analysis

Spectral analysis in octave thirds comprising 63 and 125 Hz (EU MSFD).

When possible supplemented with higher ones.

Spectral resolution of 1Hz should be provided for fmax<1 kHz

Spectral resolution of 100 Hz should be provided for fmax>1 kHz

Average and median values of SPL should be calculated together with the 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup> and 95<sup>th</sup> percentiles

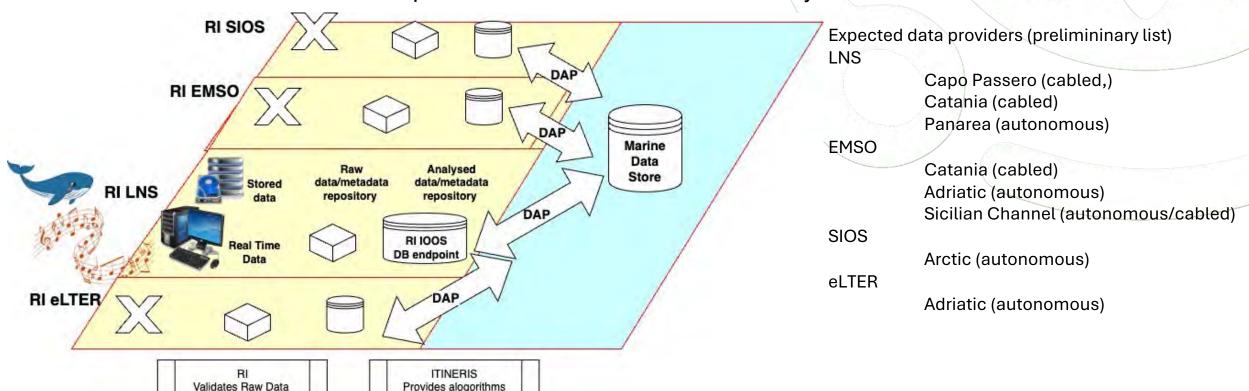


# Integrate Ocean Sound in the IIOOS (Italian Integrated Ocean Observing System)



### System Architecture & RI's contribution

Each RI will be responsible to ensure the quality and availability of raw data Both ITINERIS and the RI will be responsible of the FAIRNess of the analysed data



Open to other data providers

Ensure FAIRNess

Check FAIRness

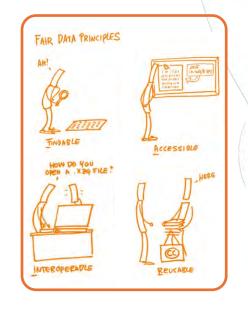


#### **Data FAIRness**

#### **Define Metadata for raw data and analysed data**

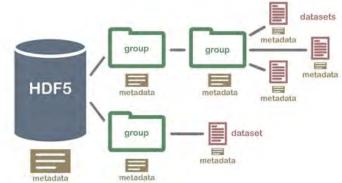
Raw file metadata
Recording Time
File Specs
Sensor &Readout Specs

SPL file metadata	
Raw file metadata	
SPL information	
Analysis Algorithm Specs	
Data Analysis Credits	



#### Save Data & Metadata in a single file

HDF5 (Hierarchical Data Format) 6x gzip compression level factor



raw data files: [INSTITUTE/OWNER]\_[PROJECT]\_[OBSERVATORY]\_[HydroID]\_[YYYYMMDD]\_[HHMMSS]\_**SIGNAL**.h5 analysed data files: [INSTITUTE/OWNER]\_[PROJECT]\_[OBSERVATORY]\_[HydroID]\_[YYYYMMDD]\_[HHMMSS]\_**SPL**.h5

#### **Vocabularies**

Institute

**Data Property** 

Physical units
Acoustic measurements
Recording devices
Data license

**Calibration Params** 

Mooring Definition

https://www.nist.gov/pml/owm/metric-si/si-units

https://www.iso.org/obp/ui/en/#iso:std:iso:3740:ed-3:v1:en

http://vocab.ices.dk/?ref=1584 http://vocab.ices.dk/?ref=1585

https://creativecommons.org/share-your-work/

https://webgate.ec.europa.eu/funding-tendersopportunities/pages/viewpage.action?pageId=1867802

https://edmo.seadatanet.org/

https://www.iso.org/standard/62406.html ISO18405



### Test Bed @RI LNS-INFN



Real-time measurement of Ocean Sound from one hydrophone installed aboard a Junction Box at the LNS deep sea cabled infrastructure of Capo Passero



- Connect to the data stream
- Produce raw data /metadata file hdf5
- SPL Analysis (Real Time)
- Store the SPL analised file hdf5
- Delete the raw files (store only a subset)



Phase-1 Cable





### Test Bed @RI LNS-INFN

#### **Harvesting Strategy:**

Read continuous data stream

Record 5 min long raw data files

Store permanently only 1 raw data/metadata HDF5 file/hour: 60 GB/day)

#### Real time an analysis:

Spectrograms

2048 FFT points

Sampling frequency = 195.3 kHz

= 2.034 kHz for low frequency analysis (decimation)

Overlap 50%

Hamming window: 2048 samples

Window length 1.5 s (15 ms) with 2 kHz (195.3 kHz) fs

Sound Pressure Level

1/3-octave frequencies bands (including 63 and 125 Hz, MSFD)

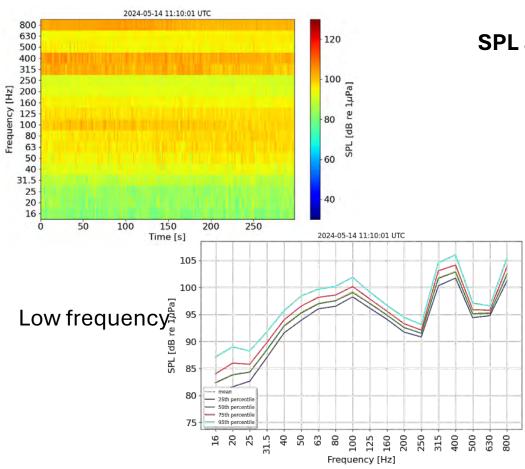
Mean, 25, 50, 75 and 95 percentiles

Save output data/metadata in HDF5 formats including metadata

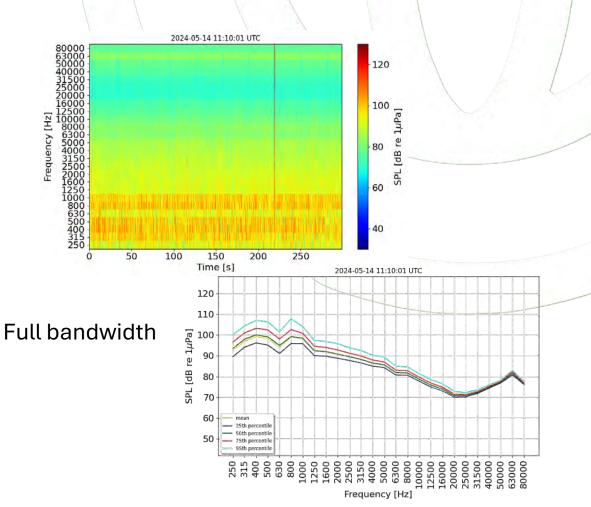
#### Produce WAV and MP3 files for outreach purposes

### **@ITINERIS**

### Test Bed @RI LNS-INFN

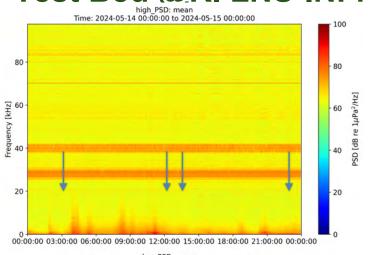


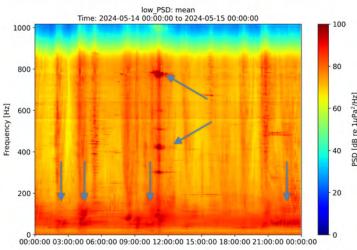




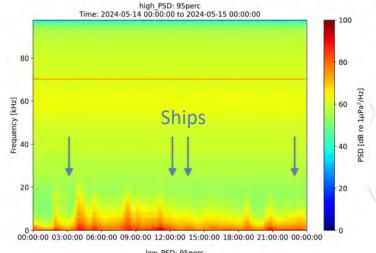


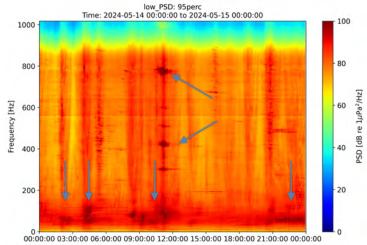
#### Test Bed @RI LNS-INFN

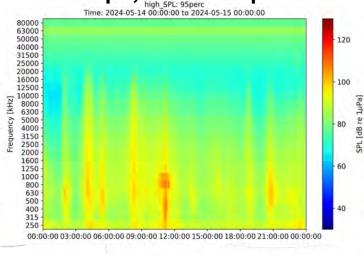


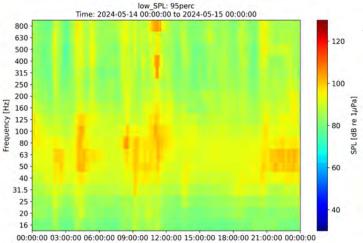


### Beyond SPL: source identification, soundscape, source separation











The Ocean Sound data collection subsystem

G. Riccobene INFN-LNS (WP5)











#### **Data FAIRness**

#### Produce raw data and metadata:

#### Coding the metadata for an analysed file:

```
"File info":{
                                                                                            # Analysis metadata creator
            "Format": "HDF5",
                                                                                                        ana info = f"""SPL data:
                        "Number of channels": 1,
                                                                                                            Unit: dB re luPa
                        "Sampling rate": [195312.5,"[Hz]"],
                                                                                                            Time window: {window lenght} [s]
                        "Quantisation": [24, "[bit]"],
                                                                    "Mooring":{
                                                                                                            FFT points: {nfft}
                        "Encoding": "AES3",
                                                                        "Mooring name": "JB1",
                                                                                                            Window type: Hamming
                        "Compression": "YES",
                                                                        "Mooring type": "SINGLE",
                                                                                                            Window points: {window point}
                        "Compression type": "gzip"
                                                                        "Seabed depth": [3450,"[m]"],
                                                                                                           Overlap: {over*100} [%]
                                                                        "Sensor depth": [3447.4, "[m]"],
                                                                                                           Third-octave band list:
        "Sensor":{
                                                                        "Easting": [587510.51,"[m]"],
                                                                                                                f central band: {fcs} [Hz]
            "Number of sensors": 1,
                                                                        "Northing": [4016865.65, "[m]"],
                                                                                                                fmin: {yticks str[0]} [Hz]
            "Nickname": "Hydro JB1",
                                                                        "WGS84 Zone": "33N",
                                                                                                                fmax: {yticks str[-1]} [Hz]
                                                                        "Date of installation": "July 2015" Number of calculated quantiles:
            "Sensor ID": 1,
            "Manufacturer Name": "co.l.mar.",
                                                                        "Date of recovery": "N.D."
                                                                                                                Average
            "Manufacturer Info":
                                                                                                                Median
"https://www.colmaritalia.it/it/home/",
                                                                    "Mooring property":{
                                                                                                                25th
            "Part number or model": "DG1330 HP",
                                                                        "Institute": "INFN-LNS",
                                                                                                                50th
            "Serial number": "SN119",
                                                                        "Project": "IDMAR",
            "Sensor LF cutoff": "N.D.",
                                                                        "Contact person name": "Giorgio
            "Sensor HF cutoff": [700,"[Hz]"],
                                                           Riccobene",
                                                                                                                Analysis algorithm: custom
            "Sensitivity":{
                                                                        "Contact person ID":
                                                                                                           Analysis:
                "Average value": [-156,"[dB re V/luPa]"], "riccobene@lns.infn.it",
                                                                                                                Date: {date now}
                "Curve": "N.D."
                                                                        "Data licence": "N.D"
                                                                                                                Author Name: Simone Sanfilippo
                                                                                                               Institute: INFN - LNS (Catania)
        },
                                                                    "Data property":{
                                                                                                                Project: {project}
                                                                        "Contact person name": "Giorgio
                                                                                                                Contact Person Name: Simone Sanfilippo
                                                           Riccobene",
                                                                                                                Contact Person ID: sanfilippo@lns.infn.it
                                                                        "Contact person ID":
                                                            "riccobene@lns.infn.it",
                                                                                                                Name of the raw data file: {source nfile}.h5
                                                                        "Data licence": "N.D"
                                                                                                                Start time: {data utc str}
                                                                                                               Duration: {Tdur} [s]
                                                                    "Notes":{
                                                                                                           Additional Notes (if any):"""
```

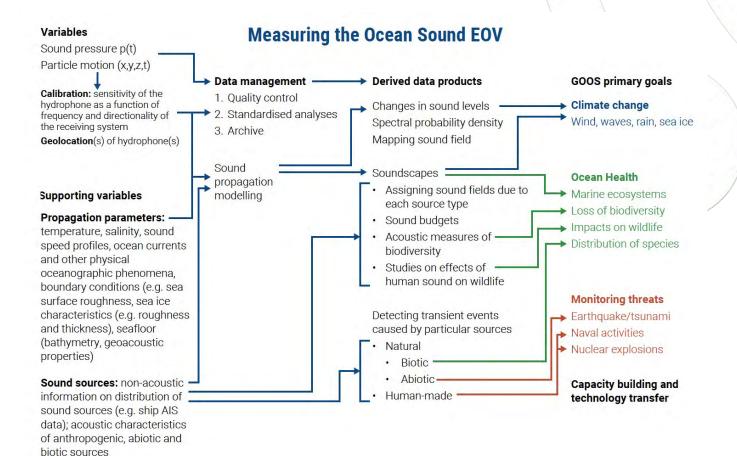
#### Storing data & metadata in a HDF5 file format:

```
# Save data and metadata in HDF format
                metaName hdf = os.path.join(dir2saveMeta,
f'{institute} {project} {site} HYDRO{hydroID} {date} SPL.h5')
                with h5py.File (metaName hdf, 'w') as hf:
                    hf.create dataset('splData', data=splData)
                    # Create a group of metadata
                    metadata/group = hf.create group('metadata')
                    # Add metadata to the group
                    metadata group.create dataset('ana info', data=ana info)
                    metadata group.attrs['ana info'] = ana info
                    with open(args.metaName json, 'r') as f json:
                        json content = f json.read()
                    # Create a group for the raw metadata in the JSON file
                    group = hf.create group('json data')
                    # Save the content of the JSON file as a group content
                    group.attrs['json content'] = json content
                print ("File successfully stored!")
```

- Name of the raw data files: [INSTITUTE/OWNER]\_[PROJECT]\_[OBSERVATORY]\_[HydroID]\_[YYYYMMDD]\_[HHMMSS]\_SIGNAL.h5
- Name of the analysed data files: [INSTITUTE/OWNER]\_[PROJECT]\_[OBSERVATORY]\_[HydroID]\_[YYYYMMDD]\_[HHMMSS]\_SPL.h5



#### Backup





WP 5
IT-IOOS: The marine Data
Store, web portal and
catalogue







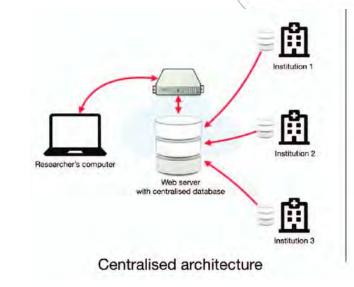


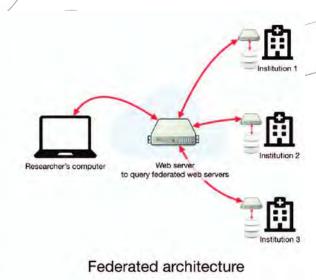


### **Definitions**



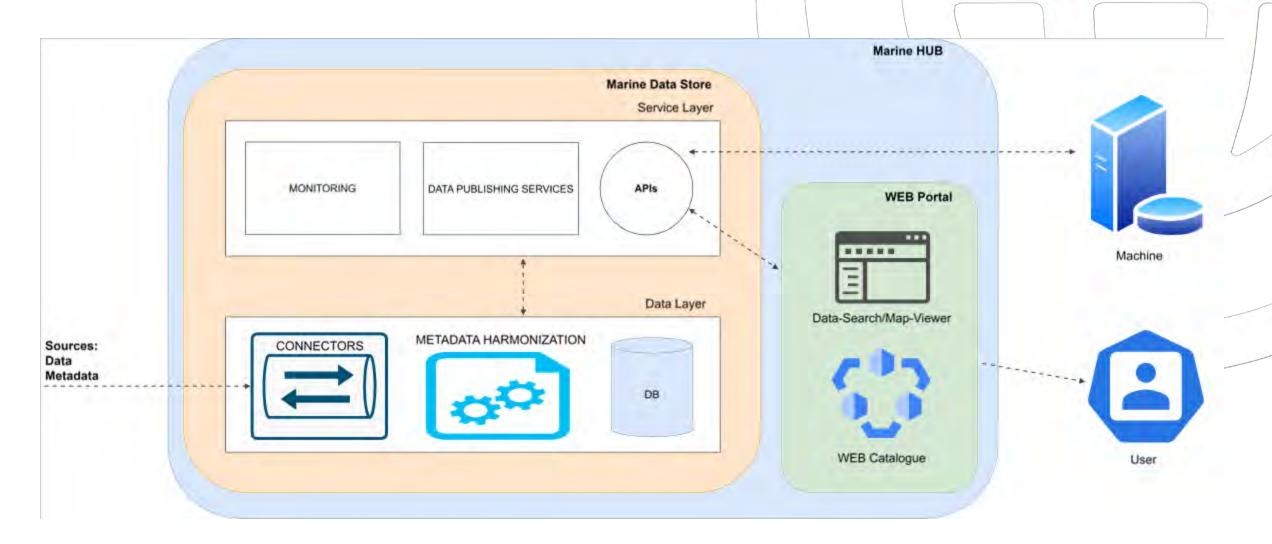
- © Cloud based solutions allow to provide **Software as a service** (SaaS) and **data as a service** (DaaS), this means that infrastructure provide resources
- © Centralized system: physical and logical facilities are managed at once in one single private cloud;
- Distributed system: the logical system is a single system but designed to operate using multiple servers in different locations to achieve faulty tolerance and parallel computing
- Federation of systems: multiple systems managed by different agents are connected through standard defined API and protocols and they act as a single system
- Service Oriented Architecture (SOA) define only interfaces between systems and not the internal architecture of components





### Marine Data Store - WEB Portal

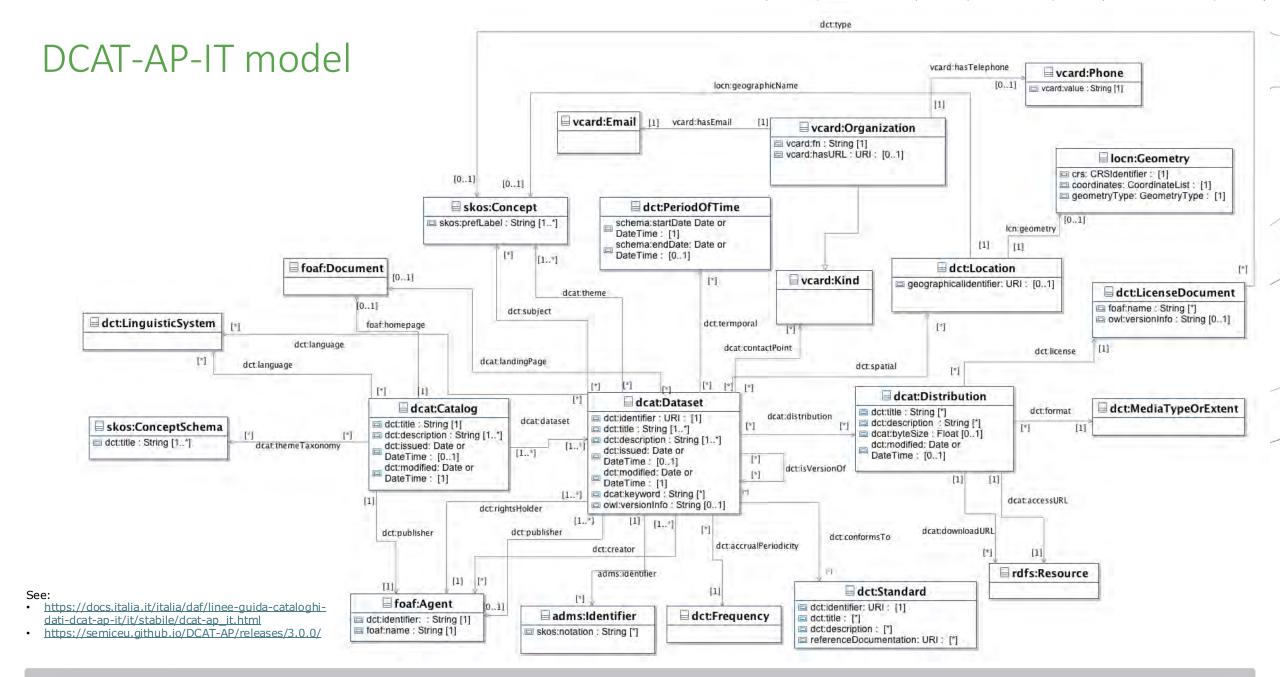




## Metadata Catalogue



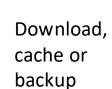
- Add proper metadata to each dataset is an essential requirement for a
   working data infrastructure
- However, since IT-IOOS data are multi-disciplinary, and each discipline uses specific metadata standard, as well as specific controlled vocabularies for annotating metadata records, the WP5 Data Catalogue infrastructure is designed to re-use as much as possible existing metadata, without requiring the original records to be re-created based on the reference standard (namely, DCAT-AP).
- ## Harvesting procedure will add metadata to the schema where necessary (e.g. label all datasets from a RI endpoint with RI name)



### Overall schema

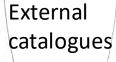
RI datastores & data servers





WP5 Marine HUB



















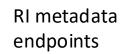


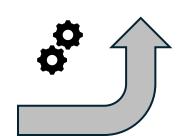








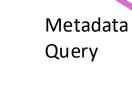




Metadata harvesting, translation & harmonization



**ITINERIS** Catalogue (WP2)











# THANKS!













WP5- Architecture design of the Italian Integrated Ocean Observing System (IT-IOOS)

Valeria Ibello & ITINERIS Marine Domain team CNR-ISMAR valeria.ibello@cnr.it









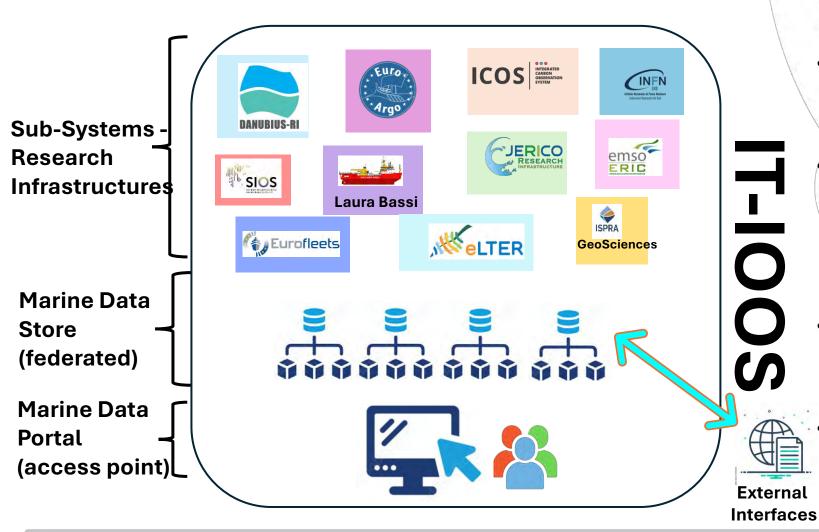


Italian Integrated Ocean Observing System (IT-IOOS):
Architecture design

General

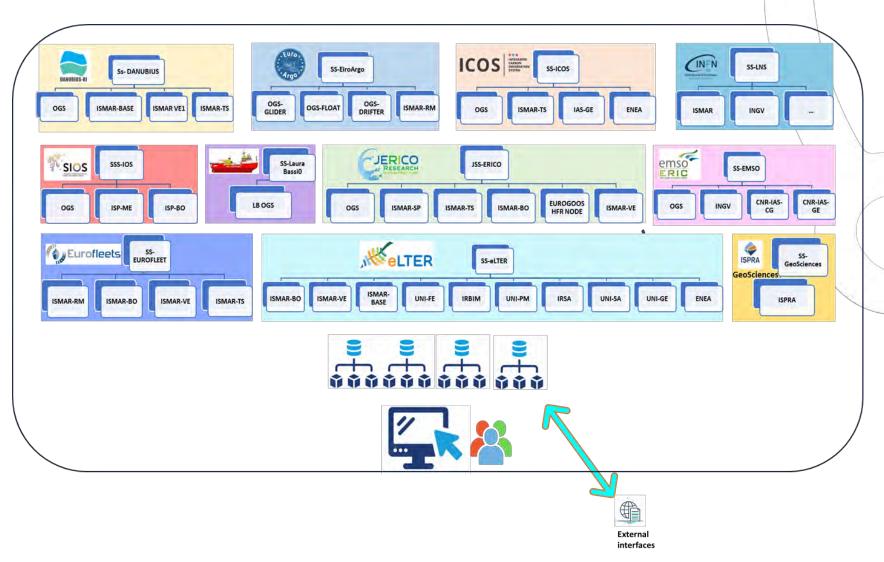


# General requirements of IT-IOOS



- Provide a **single access point** for the users to access to the entire ocean database and RIs' services
- IT-IOOS data includes all available datasets from: 11
   RIS, ITINERIS integrated marine products, able to host additional products
- Designed as a modular system configurable either at system and subsystem levels
  - Designed to allow any upgrade and integration of additional sub-systems without requiring any change of the overall system architecture.

# IT-IOOS: Sub-Systems architecture





# IT-IOOS Sub-System requirements

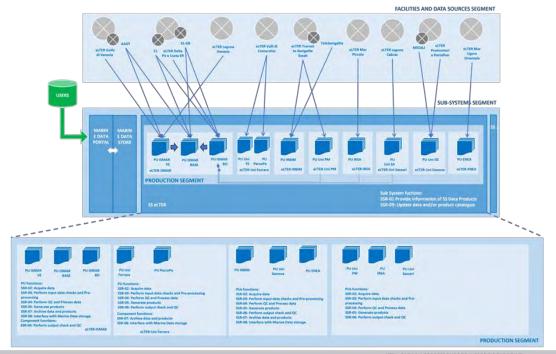
Every sub-system has to satisfy specific requirements about the data information, acquisition, management and storage.

- Providing and updating info about the data and metadata (SSR-01, SSR-09)
- Acquiring data (manually or automatically, SSR-02)
- Performing processing and quality control of data, metadata and files format (SSR-03, SSR-04, SSR-06)
- Archiving and back-uping data for at least 10 years (SSR-07)
- Providing an end-point for a data harvesting form the Marine Data Store (SSR-08)

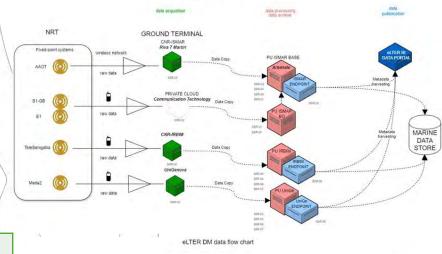
#### eLTER-RI

MISSION: Expanding the research capability to study long-term ecological changes in marine and transitional ecosystems through a holistic 'whole system' approach, based on the integration of different environmental disciplines, to understand the role and interactions of multiple and complex ecosystem variables.

SS eLTER Architecture (version 2)



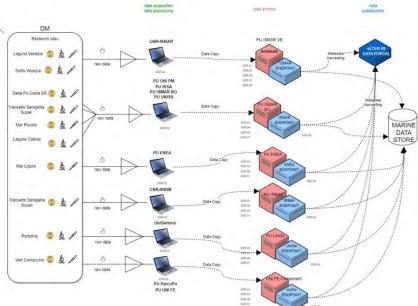




eLTER NRT data flow chart

ITINERIS

Components/ PUs	8/11
Facilties	9+5
Data transmission	DM
Data Flows	10



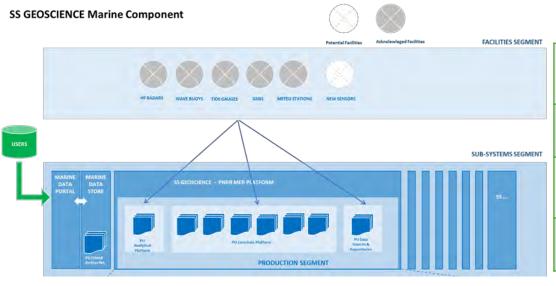
ATTN: EACH PU CORRESPONDS TO A SPECIFIC ENDPOINT
(i.e. IP ADDRESS or WEB LINK)

#### Geosciences-RI

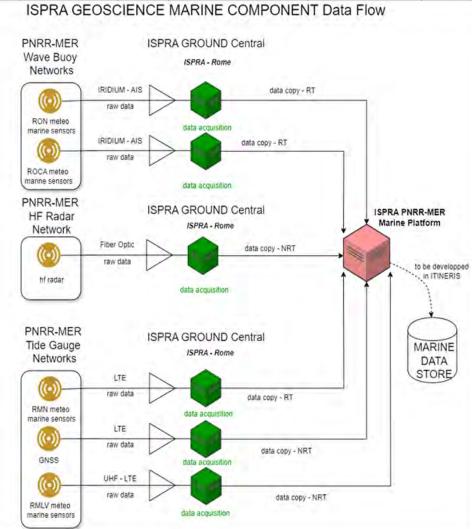


MISSION: Monitoring of Italian seas including surveilling water quality, assessing the impact of human activities, and supporting environmental policies. GEOSCIENCES also promotes scientific research and public awareness to ensure the protection and sustainability of marine ecosystems.





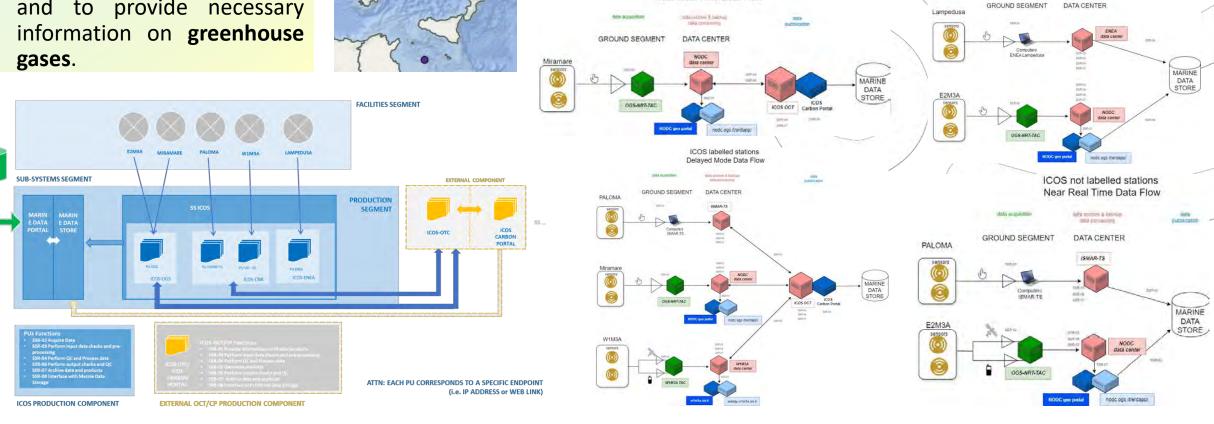
Components/ PUs	3
Facilties	6
Data	NRT
transmission	



### ICOS-ERIC

MISSION: producing standardized, high-precision and long-term observations and facilitate research to understand the carbon cycle and to provide necessary information on greenhouse gases.





**Components/PUs** 

**Data transmission** 

ICOS labelled stations Near Real Time Data Flow

**Facilties** 

**Data Flows** 

3/4

4

8

NRT/DM

ITINERIS

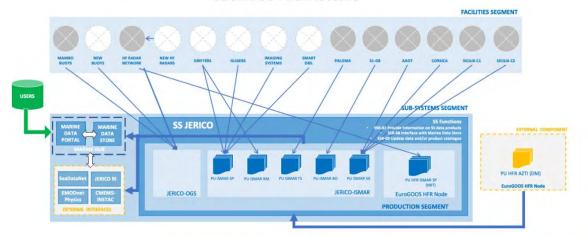
ICOS not labelled stations Delayed Mode Data Flow

### JERICO-RI

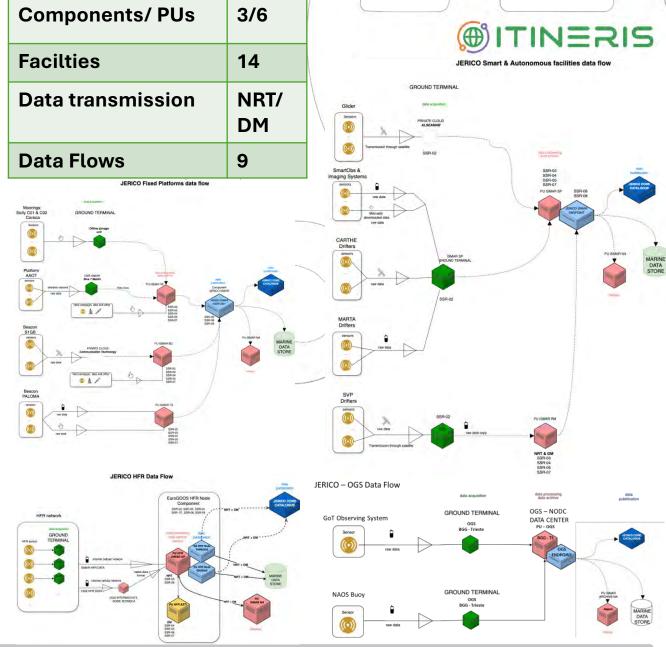
MISSION: implementing a system of observation and related services for European coastal seas to address the complexity of marine coastal systems.



#### **SS JERICO Architecture**



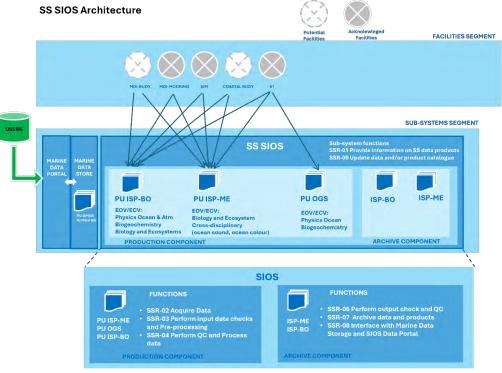




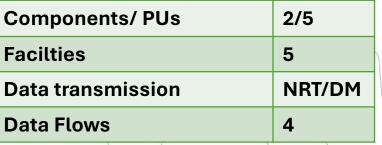
### SIOS-RI

MISSION: Expanding the research capacity to investigate the artic environment of the Svalbard region in a multidisciplinary way



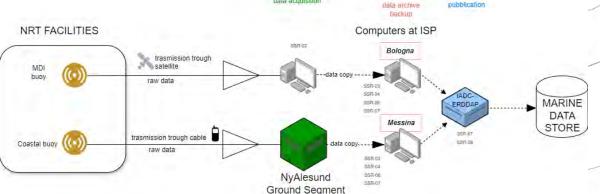


ATTN: EACH PU CORRESPONDS TO A SPECIFIC ENDPOINT (i.e. IP ADDRESS or WEB LINK)



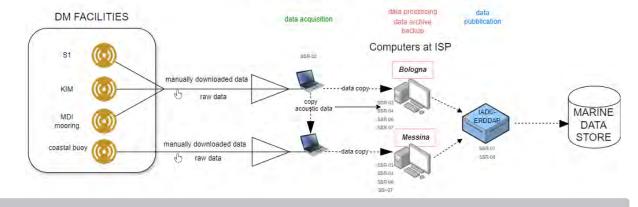


#### SIOS data flow chart Near Real-Time mode



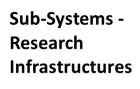
data acquisition

#### SIOS data flow chart Delayed Mode



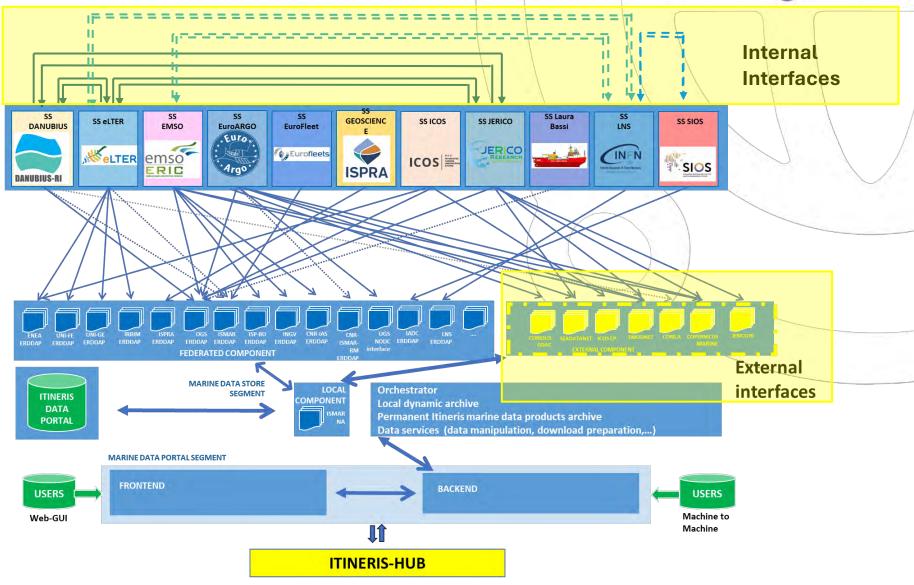
### Internal and External interfaces of IT-IOOS





Marine Data Store (federated)

Marine Data Portal (access point)





# THANKS!

















# Source apportionment of PM<sub>2.5</sub>, PM<sub>10</sub>, and Oxidative Potential at different typology of sites

<u>Serena Potì<sup>1,4</sup></u>, Eva Merico<sup>1</sup>, Marianna Conte<sup>2</sup>, Florin Unga<sup>1</sup>, Daniela Cesari<sup>1</sup>, Adelaide Dinoi<sup>1</sup>, Maria Rachele Guascito<sup>1,3</sup>, Anna Rita De Bartolomeo<sup>3</sup>, Alessandro Carlino<sup>3</sup>, Antonio Pennetta<sup>1</sup>, Ermelinda Bloise<sup>1</sup>, Giuseppe Egidio De Benedetto<sup>5</sup>, Roberto Ferrera<sup>6</sup>, Enrico Bompadre<sup>6</sup> e Daniele Contini<sup>1</sup>

1 Istituto di Scienze dell'Atmosfera e del Clima (ISAC), Consiglio Nazionale delle Ricerche (CNR), Lecce

2 Istituto di Scienze dell'Atmosfera e del Clima (ISAC), Consiglio Nazionale delle Ricerche (CNR), Roma

3 Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali DiSTeBA, Università del Salento, Lecce

4 Dipartimento di Ingegneria dell'Innovazione, Università del Salento, Lecce

5 Dipartimento di Beni Culturali, Università del Salento, Lecce

6 FAI Instruments s.r.l., Roma











### **INTRODUCTION AND OBJECTIVES**





To investigate spatial and seasonal variabilities of PM concentrations and chemical composition.



To investigate spatial and seasonal variabilities of oxidative potential (via DTT assay) and how OP is associated with chemical composition and sources.











- Flow-rate 2 L/min.
- Sampling period ~30 days.
- 47 mm quartz filters (Whatman).
- Possibility to use with both electrical power or solar panels.
- SIM for remote control.



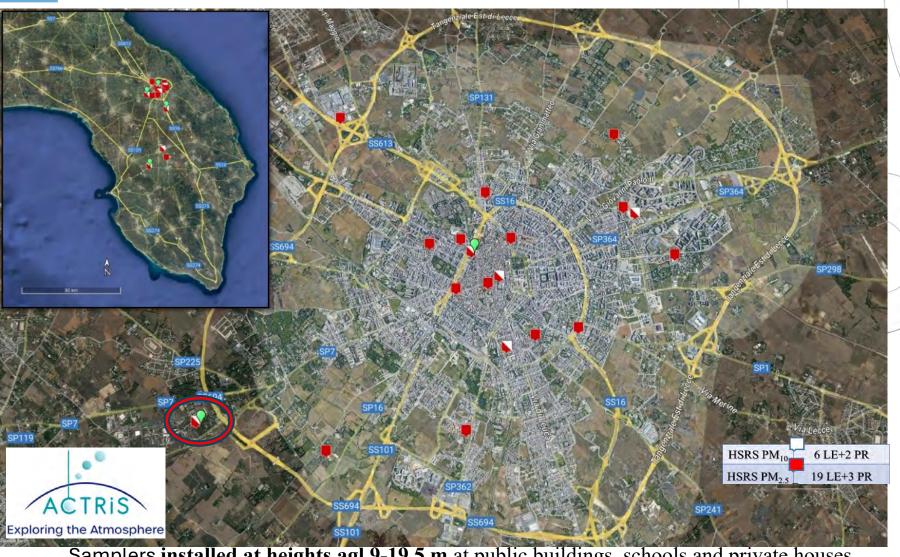
#### **SAMPLING SITES**

### ITINERIS

- 24 sites in total. 21 in the area of Lecce and 3 in small villages 25000 inhabitants in the province).
- One site co-located at the ECO observatory of Lecce.
- 30 samplers in total: 22 for  $PM_{2.5}$  and 8 for  $PM_{10}$ .

#### Classification of the sites

- FU/S: 11 sites of urban background/city background.
- **TU**: 8 sites urban traffic.
- I/CS: 2 sites at large commercial centers.
- **PR:** 3 sites in the province of Lecce.



Samplers installed at heights agl 9-19.5 m at public buildings, schools and private houses

Sampling campaign: Dec 2021 - Dec 2022

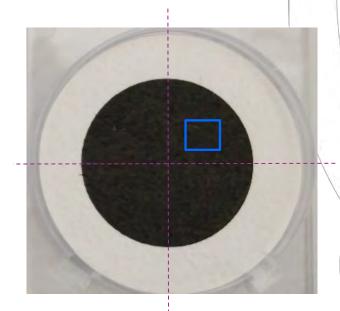


### LABORATORY ANALYSIS



Main elements ED-XRF









Water soluble ions Ion chromatrography





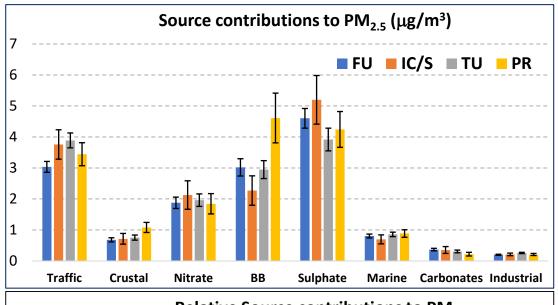


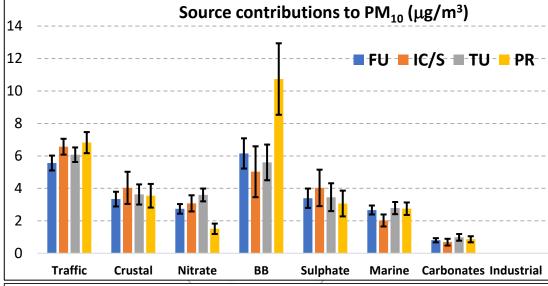
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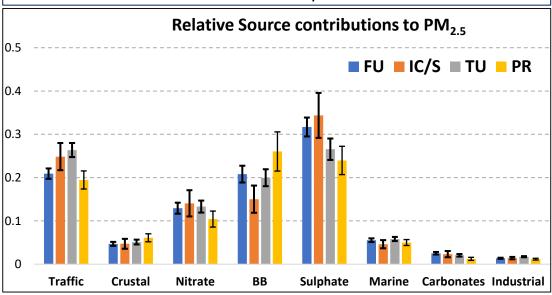


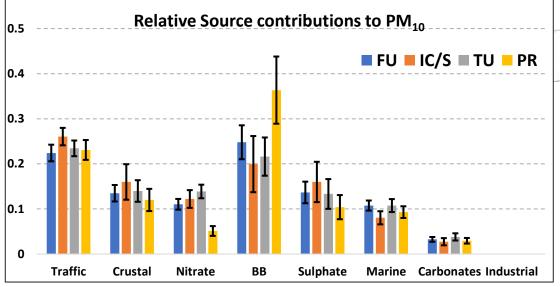
### Trends of the source contributions to PM









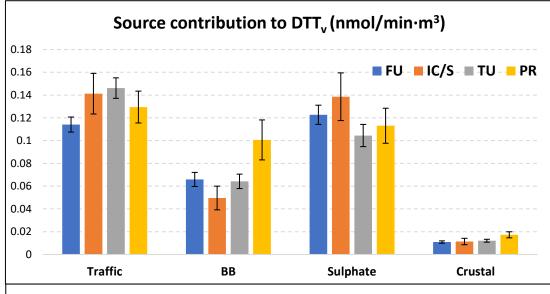


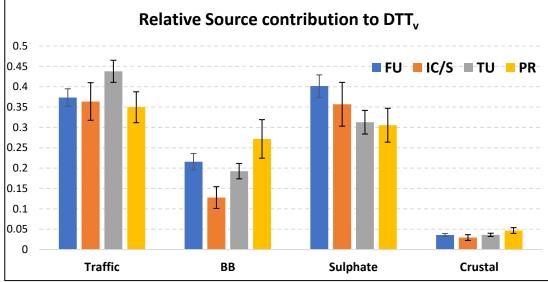


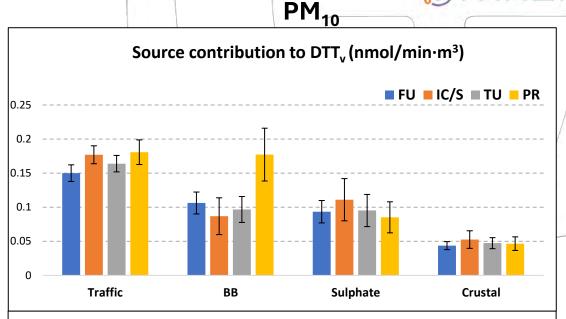
### Trends of the PM source contributions to OP

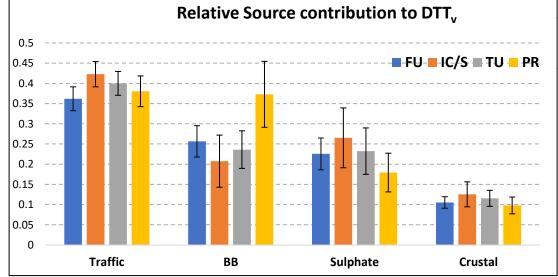














### **Conclusions and Future Activities**



- The seasonal trend is larger than the spatial trend for all variables considered, with higher values during autumn/winter periods (PM, OC, EC, K), especially at background sites and at the PR sites;
- SA is in line with the trend of chemical compounds and the stoichiometric analysis
  of the crustal, marine and secondary inorganic source;
- Trends in source contributions to the OP show the predominant role of combustion sources, especially for the PR site.



Future plan is to apply MLR analysis by unifying  $PM_{10}$  and  $PM_{2.5}$  to identify other possible sources currently not statistically significant. In addition, variability between sites of the same type (intra-site), will be investigated to identify possible local sources.



# (#) ITINERIS

With the support of the projects





**Exploring the Atmosphere** 

# THANKS!

serena.poti@unisalento.it













# Tests and applications of seismic arrays in different urban contexts

 Vincenzo Serlenga et al., National Research Council of Italy, Institute of Methodologies for Environmental Analysis











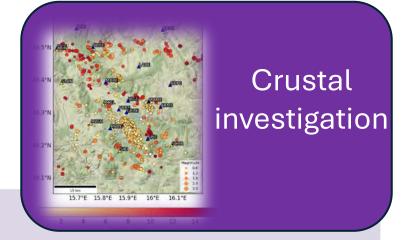




A seismic array is a set of seismoters deployed so that characteristics of the seismic wavefield can be inferred by analyzing waveforms recorded at different sites.

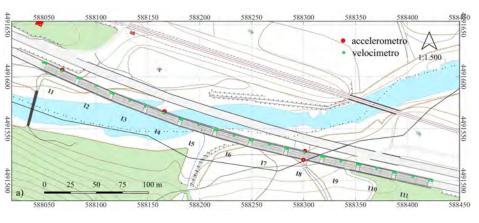


Shallow subsoil characterization and soil-structure interaction.



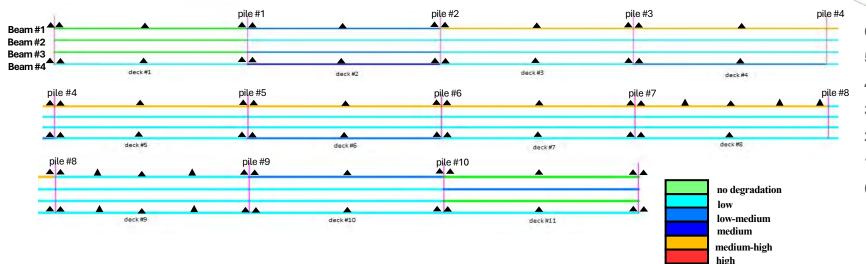


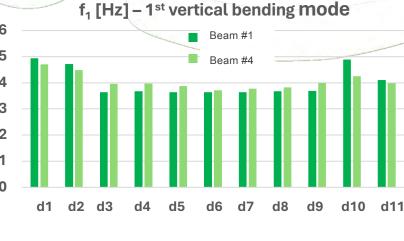
# Monticello Bridge - Infrastructure Characterization





Estimation of bridge eigenfrequencies at different decks and beams as a function of the degradation level







# Santa Sofia Bell Tower in Benevento - CH soil/foundation characterization and soil-CH structure interaction









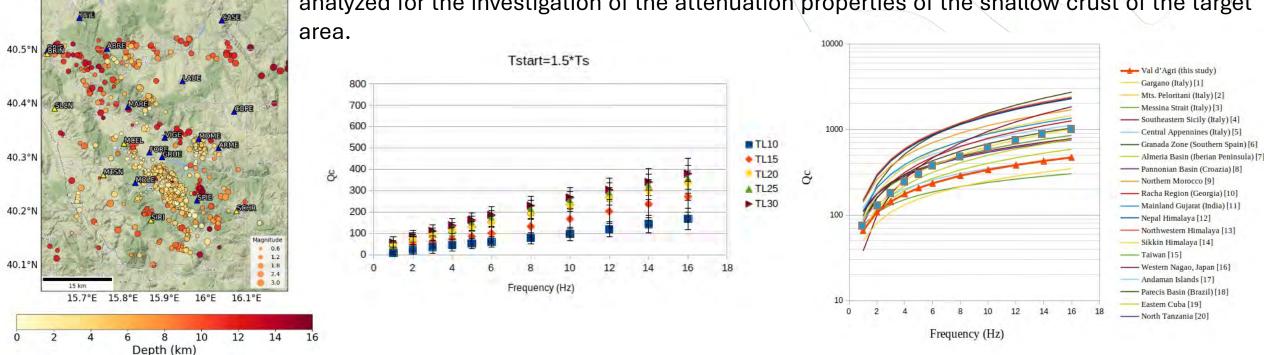


Passive seismic data acquisition campaign carried out three weeks ago in Benevento for the characterization of the shallow subsoil in the area of Santa Sofia Bell Tower, of the building and of its interaction with the surface soils.



# High Agri Valley – Attenuation crustal studies from earthquake recordings

1462 earthquakes recorded in the period 2001 – 2014 in the High Agri Valley have been analyzed for the investigation of the attenuation properties of the shallow crust of the target



The quality factor is a key parameter for seismic wave propagation studies and seismic hazard assessments

Annual meeting – Rome – 9-10/07/2024 5



# Future Perspectives and Developments

Tested an Validated Methodologies



New Geophysical Equipment



More accurate demonstrations in the pilot sites of the Task 7.4 of the Project





Seismic array consisting of 11 accelerometers, 35 0.5 Hz velocimeters and a nodal system of 60 4.5 Hz 3C geophones for the analysis of the near surface – infrastructure interactions, microzonation studies and microseismic monitoring.



# THANKS!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"













# Variability of black carbon in Mediterranean free troposphere, a long-term perspective

16 years of black carbon observations at the Monte Cimone observatory

M. Zanatta<sup>1</sup>, L. Renzi<sup>1</sup>, C. Magnani<sup>1</sup>, D. Putero<sup>1</sup>, P. Cristofanelli<sup>1</sup>, F. Vogel<sup>1</sup>, P. Bonasoni<sup>1</sup> and A. Marinoni<sup>1</sup>
<sup>1</sup>Institute of Atmospheric Sciences and Climate – National Research Council of Italy, Bologna, Italy

Contact: m.zanatta@isac.cnr.it

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"







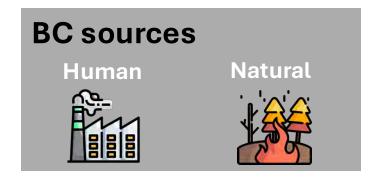


### Black carbon aerosol in a nutshell



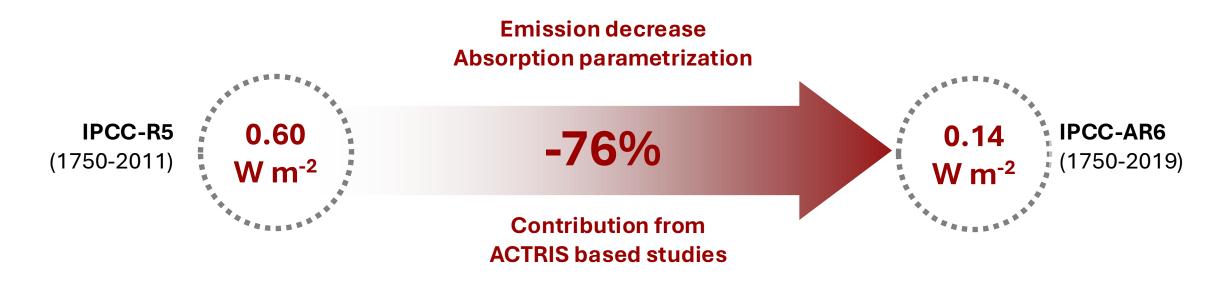
#### **BC** properties







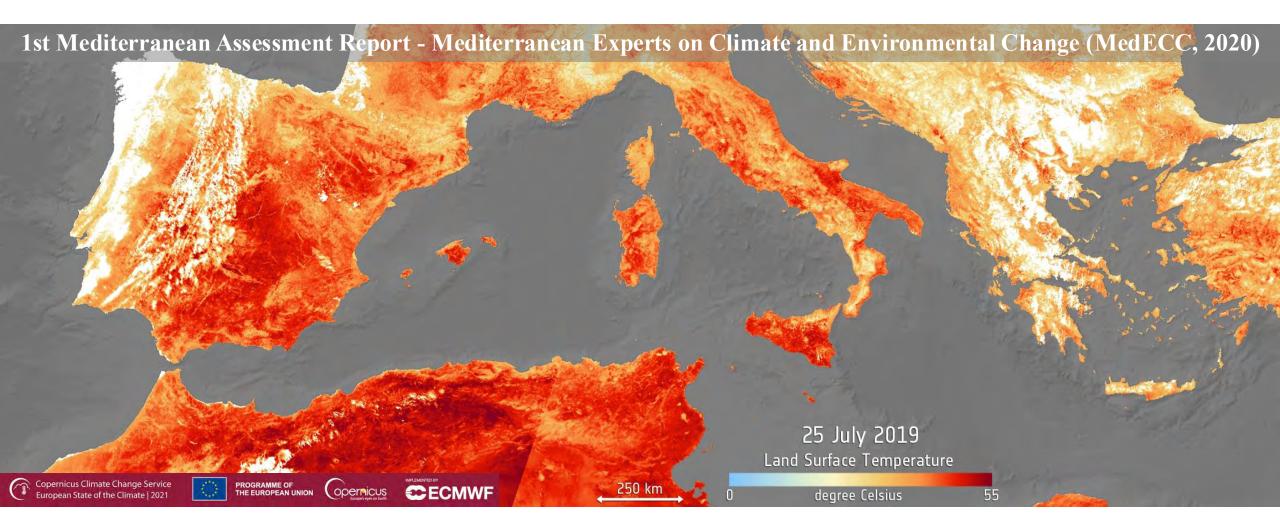
#### Revision of BC effective radiative forcing (aerosol radiation interaction)



# A changing mediterranean atmosphere



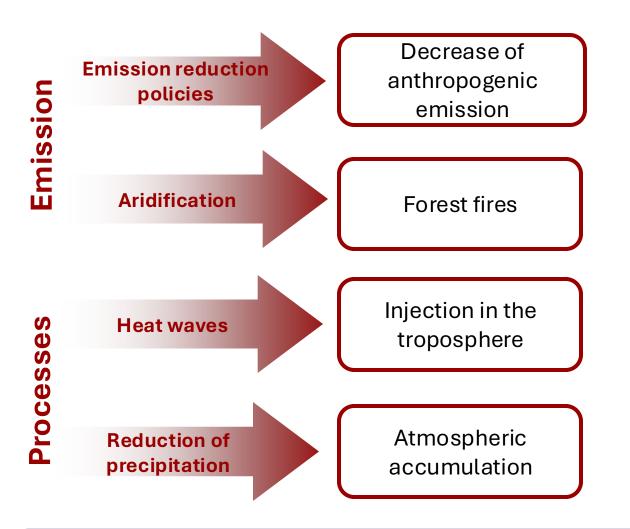
The Mediterranean region has undergone a warming trend 20% more rapid than the global average Projections indicate that by the end of the century, temperatures will be 50% warmer than the global mean

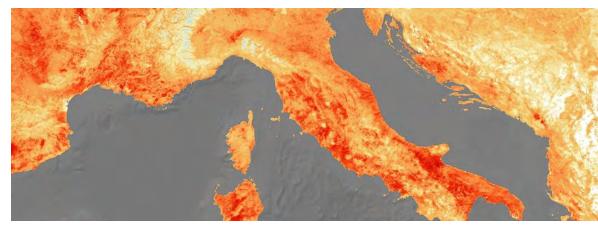


# BC in changing mediterranean atmosphere

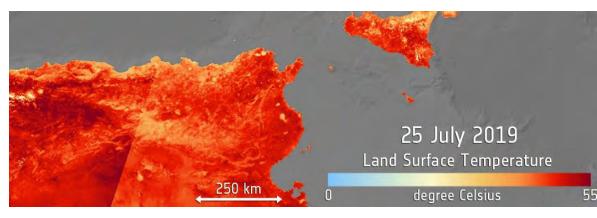


The Mediterranean region has undergone a warming trend 20% more rapid than the global average Projections indicate that by the end of the century, temperatures will be 50% warmer than the global mean





BLACK CARBON
MEDITERRANEAN ANOMALIES



# BC in changing mediterranean atmosphere



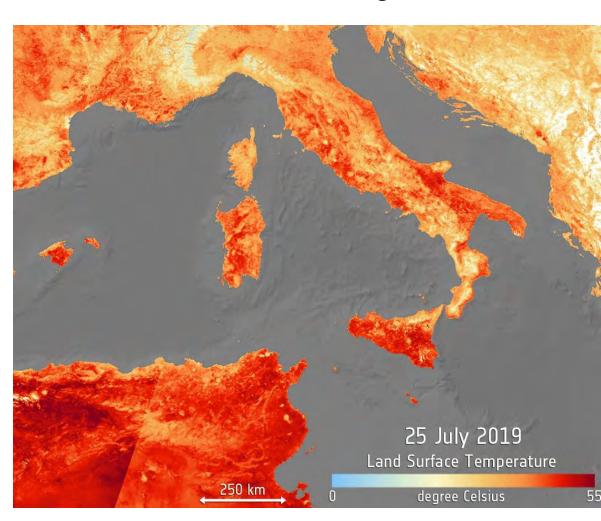
The Mediterranean region has undergone a warming trend 20% more rapid than the global average Projections indicate that by the end of the century, temperatures will be 50% warmer than the global mean

Did the emission reduction policies impact the atmospheric concentration of BC?

Can we identify BC anomalies connected with Mediterranean warming?



Analysis of long-term observation of equivalent black carbon at the Italian station of Monte Cimone



# BC in changing mediterranean atmosphere



The Mediterranean region has undergone a warming trend 20% more rapid than the global average Projections indicate that by the end of the century, temperatures will be 50% warmer than the global mean

The "Ottavio Vittori Observatory"

Italy (44°12' N, 10°42' E)

Peak of Monte Cimone (2165 m asl)

**Networks** 

GAW, ACTRIS and ICOS

#### Meteorology

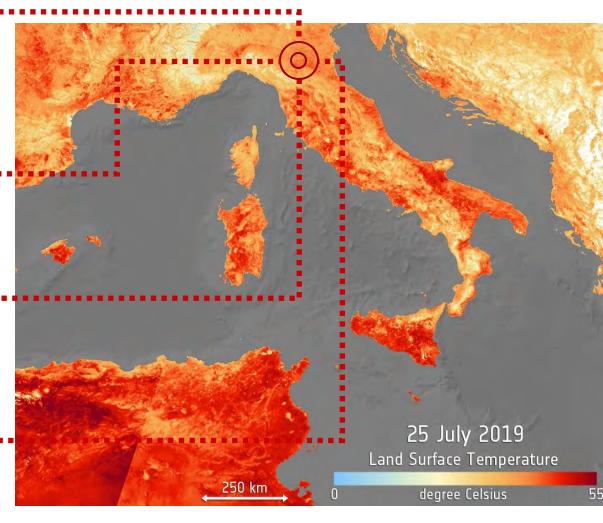
Seasonal evolution of boundary layer

Cold winter: free troposphere

Warm summer: boundary layer

#### **Aerosol representativity**

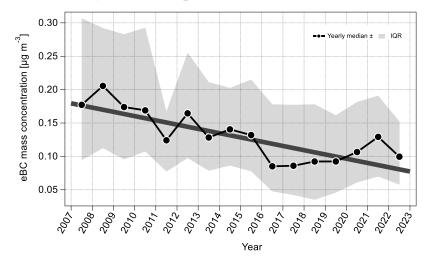
Long range transport Po Valley pollution



# A generalized decreasing BC trend?



Least square regression on annual values without prewhitening

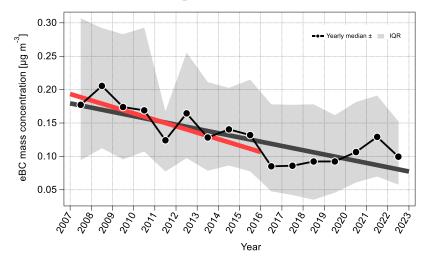


**2007-2023 trend** -64 ng m<sup>-3</sup> per decade

# A generalized decreasing BC trend?



Least square regression on annual values without prewhitening



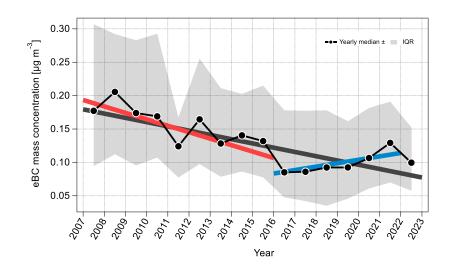
**2007-2023 trend** -64 ng m<sup>-3</sup> per decade

2007-2016 tendency -96 ng m<sup>-3</sup> per decade

Concentration decrease at Cimone, does it tell a complete story?

# A generalized decreasing BC trend?





**2007-2023 trend** -64 ng m<sup>-3</sup> per decade

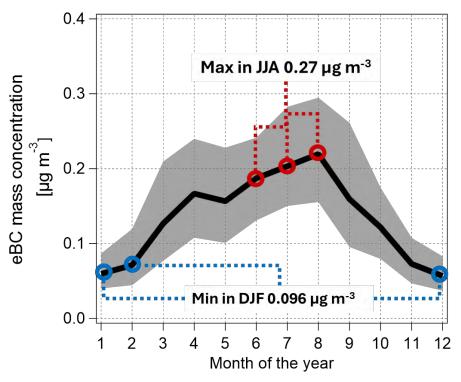
2007-2016 tendency -96 ng m<sup>-3</sup> per decade

**2016-2022 tendency** +31 ng m<sup>-3</sup> per decade

Concentration decrease at Cimone, does it tell a complete story?



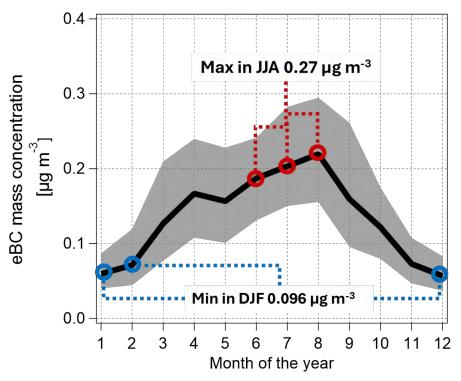
#### eBC seasonal cycle 16 years



Seasonality with polluted summer period: influence of boundary layer



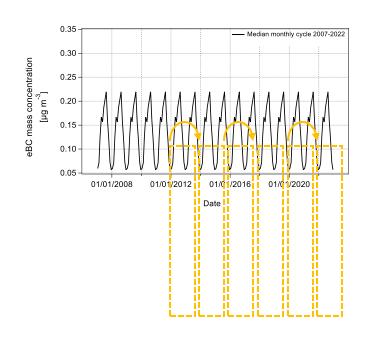
#### eBC seasonal cycle 16 years



Seasonality with polluted summer period: influence of boundary layer

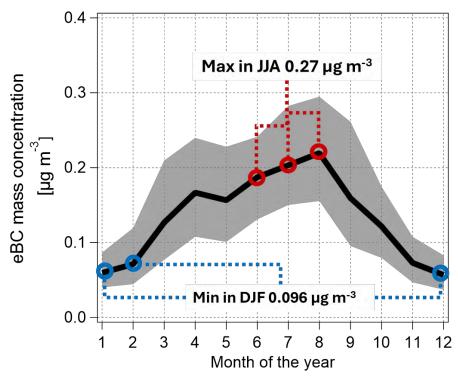
#### eBC de-seasonalizied anomaly

Concatenation of median seasonal cycle





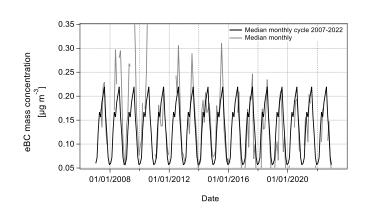
#### eBC seasonal cycle 16 years



Seasonality with polluted summer period: influence of boundary layer

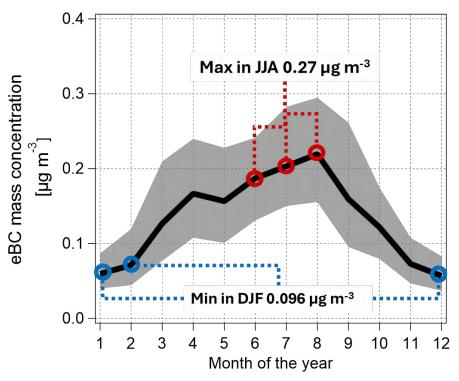
#### eBC de-seasonalizied anomaly

Overposing the monthly concentration





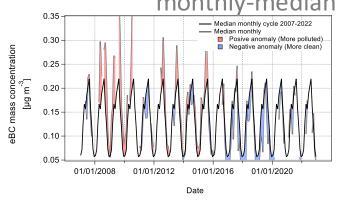
#### eBC seasonal cycle 16 years



Seasonality with polluted summer period: influence of boundary layer

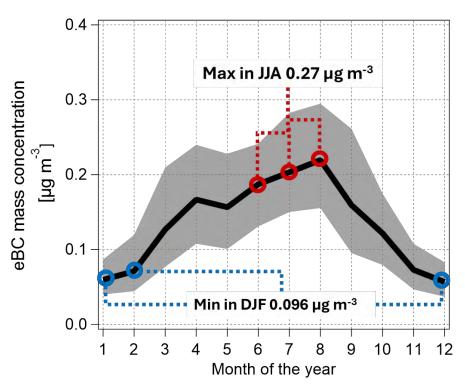
#### eBC de-seasonalizied anomaly

Anomaly calculated as the difference between monthly-median and median-seasonal-cycle





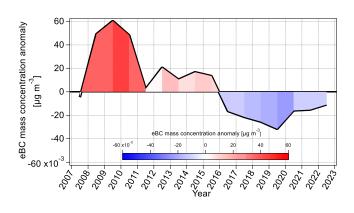
#### eBC seasonal cycle 16 years



Seasonality with polluted summer period: influence of boundary layer

#### eBC de-seasonalizied anomaly

Yearly median anomaly



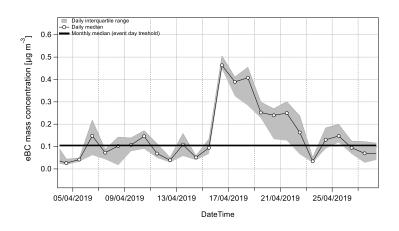
From polluted period (positive anomaly) 2007-2016
To clean period (negative anomaly) 2016-2022

# Dataset decomposition: pollution events



#### **Event identification**

- Daily interquartile range
- Monthly median value

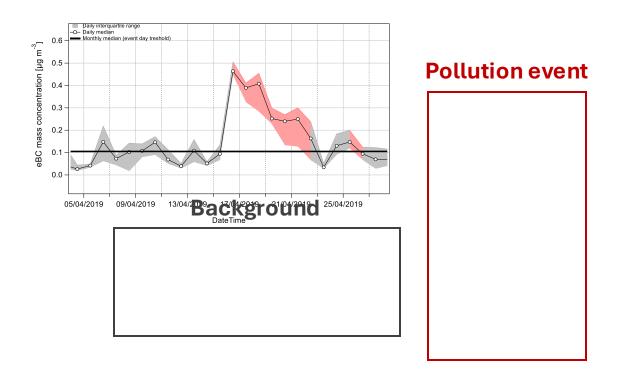


# Dataset decomposition: pollution events



#### **Event identification**

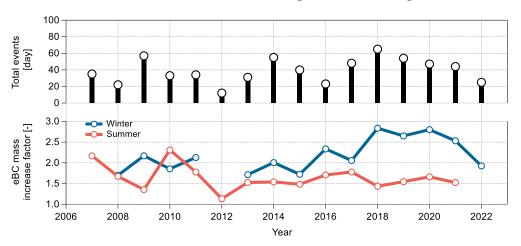
- Daily 25<sup>th</sup> percentile > monthly median → polluted day
- 3 consecutive polluted days  $\rightarrow$  pollution event



## Dataset decomposition: pollution events



#### 16 years of pollution events statistics



No increasing or decreasing trend in total event days

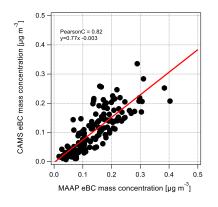
Concentration increase by 50% in summer - Concentration increase in winter factor 2

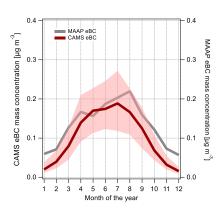
# Performances of CAMS product



#### CAMS BC concentration: hydrophilic + hydrophobic BC mixing ratio

- Nearest CAMS point to CMN (32 km)
- Model level 46: 2300 m asl





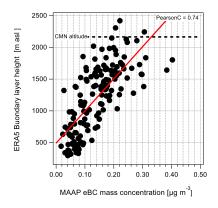
High correlation and concentration within 30%

CAMS reproduces the seasonal cycle

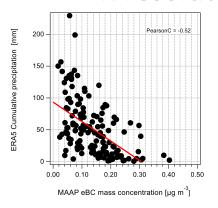
# **Explaining variability with reanalysis data?**



**ERA-5 boundary layer height** h resolution at Po-Valley



**ERA-5 large scale prec.** h resolution at CMN



Boundary layer dynamic Vertical transport from Po-valley Precipitation events Local wet removal

## **Evolution of BC at Cimone**



BC concentration in a Mediterranean background station are decreasing Recent anomaly since 2016

#### What's next?

Trend analysis

Mediterranean warming

More?

- Day/Month resolution
- Prewhitening
- Season
- Day/night

#### **ERA5** integration

- Injection From Po Valley (PBL height)
- Removal (Precipitation)
- Heat waves (Temperature)

m.zanatta@isac.cnr.it



# THANKS!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"











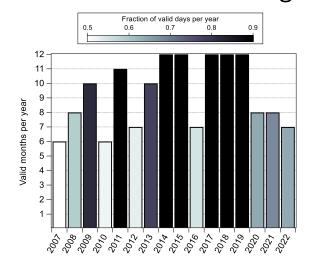
# Equivalent BC observation: data coverage



#### Filter based absorption photometer: Multi Angle Absorption Photometer (MAAP)

Data reduction following "Guidelines for Manual QC of MAAP data"

(T. Muller and M. Fiebig)



#### Overall data coverage

- 16 years
- 148 valid months
- 4355 valid days



- All years 50% of valid days
- 6 years 90% of valid days <sup>a</sup>
- 2018 best data coverage 350 days

<sup>a</sup> more than 11 months & 330 days



- 5 years incomplete seasonality b
- 2007 worst data coverage 183 days

<sup>b</sup> Missing 3 months as DJF, MAM, JJA, SON



Impact of planetary boundary layer dynamics on atmospheric pollutants at ground: one-year field campaign in Milan

Camilla Perfetti<sup>1,2</sup>, Annachiara Bellini<sup>3,4</sup>, Laura Renzi<sup>1</sup>, Marco Zanatta<sup>1</sup>, Luca Di Liberto<sup>1</sup>, Ferdinando Pasqualini<sup>1</sup>, Alessandro Bracci<sup>1</sup>, Francesca Barnaba<sup>1</sup> and Angela Marinoni<sup>1</sup>

Contact: c.perfetti@isac.cnr.it

1 ISAC-CNR, 2 UNIBO, 3 UNISAPIENZA, 4 ARPA VDA

**IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System** (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"









## ITINERIS campaign in MILAN - 2023\*



**Objective WP 4.14:** Impact of the Planetary Boundary Layer dynamics on aerosol and trace gases concentration at the ground

Objective Milan 2023: - Impact of the PBL dynamics on ground concentrations in urban environment - Impact of hotspot emissions in concentrations

#### How:

- January September 2023
- Remote sensing measurements (Milano-Bicocca)
- In-situ measurements: urban background site (Milano-CNR) & hotspot site (Linate airport)

Annual meeting - Rome - 9-10/07/2024

Bollate
Balossa
Bresso
Novate
Balossa
Novate
Balossa
Novate
Consider

Ospedale Sacco
Place Ospedale
Sesto San
Sovanni
Monzese
Sesto San
Sovanni
Monzese
San Raffacele
Carscenta do
San Felice

Milano
Mudeo - Museo
Milano
Monzese
Segrate

Europark
Milano
San Felice
Aerosol physics
Aerosol chemistry
Gas

Corsico

Buccinasco

Buccinasco

Lomato
Milanese

Corsico

Co

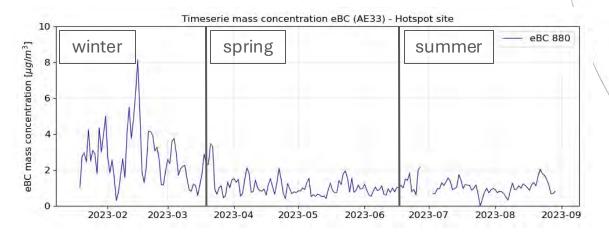
<sup>\*</sup>Conducted in sinergy with the RI-URBANS EU H2020 project

## In-situ & vertical measurements: MILAN 2023



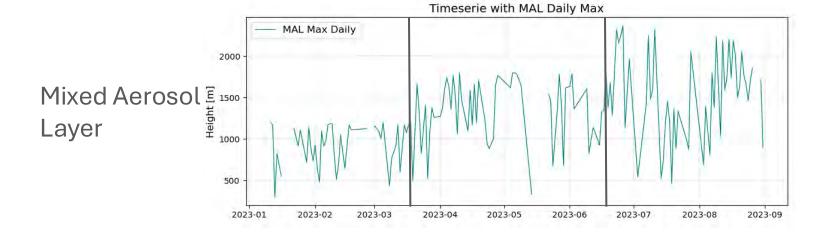
#### Seasonality variation





Winter: 2.72 µg/m<sup>3</sup> Spring: 1.72 µg/m<sup>3</sup>

Summer: 1.25 µg/m<sup>3</sup>



Winter: 925.16 m

Spring: 1365.96 m

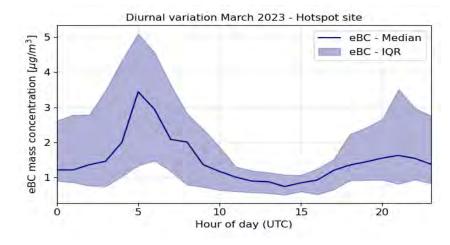
Summer: 1536.83 m

### In-situ & vertical measurements: MILAN 2023

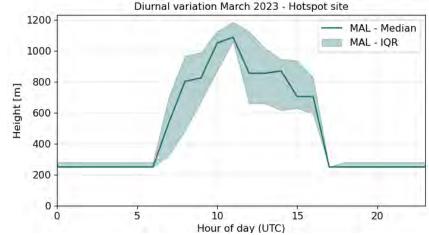


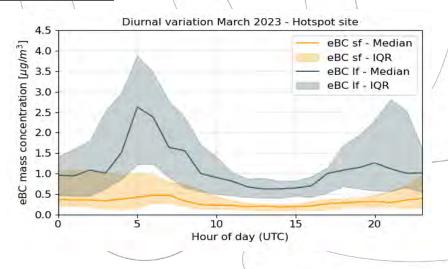
#### Monthly diurnal variation

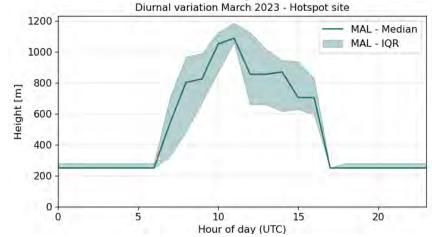




Mixed Aerosol Layer







## Conclusions & Future perspectives:

- Finalized dataset
- Marked PBL and ground concentrations seasonality

- Combine in-situ and vertical stratification for all months and available variables
- Quantify the dilution index
- Compare it with different sites
- Focus on heat waves periods
- Identify case studies via remote sensing
- Identify the possible impact of airport hotspot (comparison with the urban background site)
- Bellini, A., Diémoz, H., Di Liberto, L., Gobbi, G. P., Bracci, A., Pasqualini, F., and Barnaba, F.: Alicenet An Italian network of Automated Lidar-Ceilometers for 4D aerosol monitoring: infrastructure, data processing, and applications, EGUsphere [preprint]
- Using Aerosol Light Absorption Measurements for the Quantitative Determination of Wood Burning and Traffic Emission Contributions to Particulate Matter, Jisca Sandradewi, Andre S. H. Prévôt, Sönke Szidat, Nolwenn Perron, M. Rami Alfarra, Valentin A. Lanz, Ernest Weingartner, and Urs Baltensperger, Environmental Science & Technology 2008 42 (9), 3316-3323





# THANKS!

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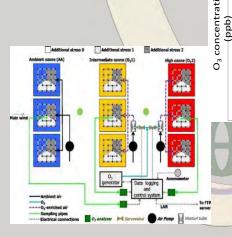


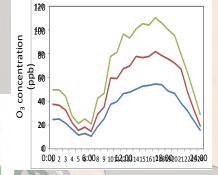


# FO<sub>3</sub>X 2.0: The future of Free-Air Concentration Enrichment

- Dr. Elena Paoletti
- IRET-CNR of Florence

The current O<sub>3</sub> FACEs in the world are 7









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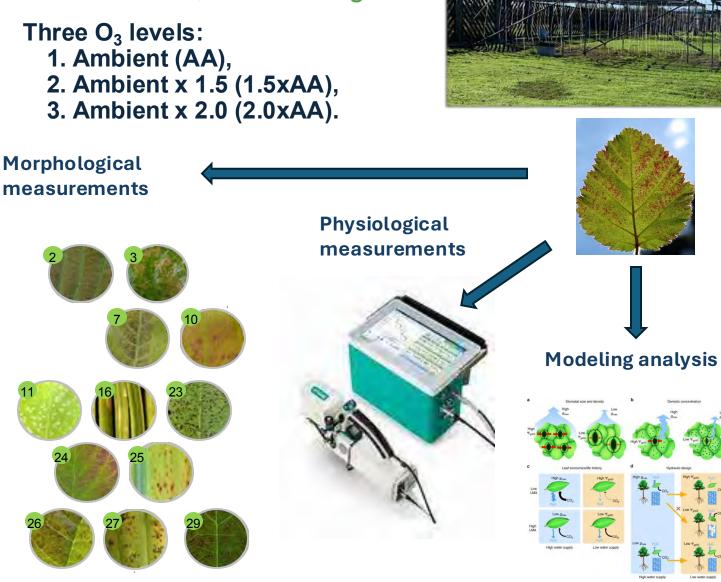


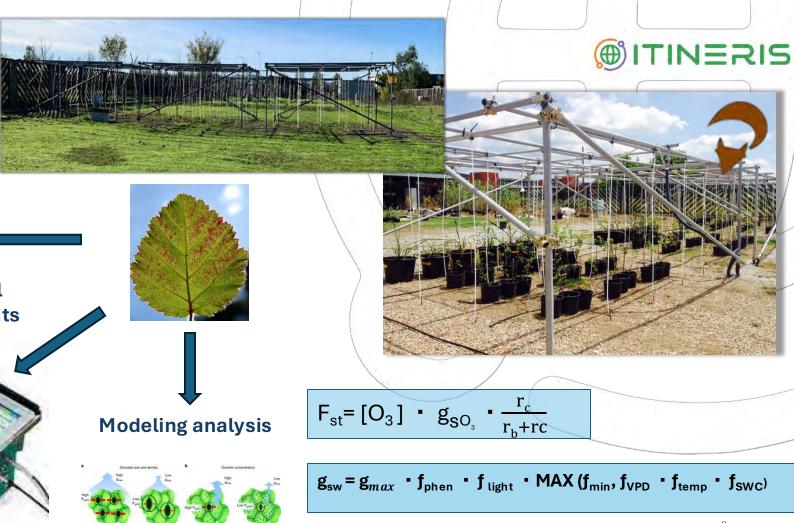






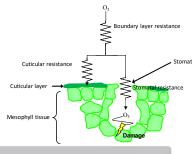
# Present day: The FO<sub>3</sub>X





$$g_{sw} = g_{max} \cdot f_{phen} \cdot f_{light} \cdot MAX(f_{min}, f_{VPD} \cdot f_{temp} \cdot f_{SWC})$$

$$g_s = g_{min} + 1.6 \cdot \left(1 + \frac{g_1}{\sqrt{D + (k/1.6)[O_3]_{air}}}\right) \frac{A}{C_a}$$

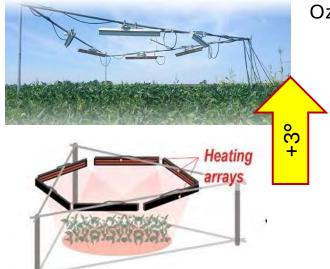


#### ITINERIS PNRR PROJECT: THE FUTURE IS NOW



#### «HeatFACE»

Temperature Free-Air controlled enhancemente



#### ${\rm «CosmO_3FACE}{\rm »}$

Ozone effects on benthic meiofauna and aquatic plants within mesocosms



«Pest-FACE»
Ozone effect on pest
animal behaviour





## Moreover! Coming soon...





Free Air CO<sub>2</sub> Enrichment (FACE)





# THANKS!













# Versatile applications of volatilome analysis across different matrices.

Daniela D'Esposito, Maurilia Maria Monti, Liberata Gualtieri, Simona Gargiulo, Francesca Palomba, Mariachiara Cangemi, Francesco Loreto, Mauro Centritto, Michelina Ruocco











# Versatile applications of volatilome analysis across different @ITINERIS matrices



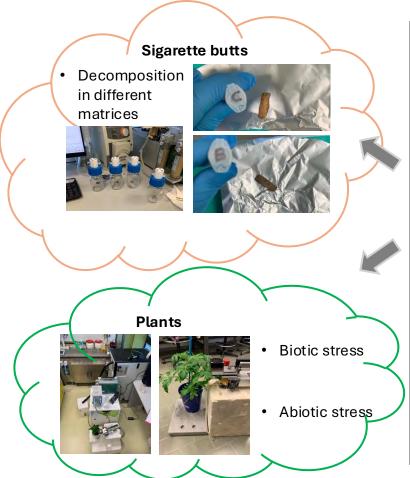
Objective

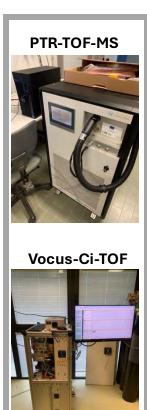
Phenotyping data collection to flow toward the ITINERIS Hub.

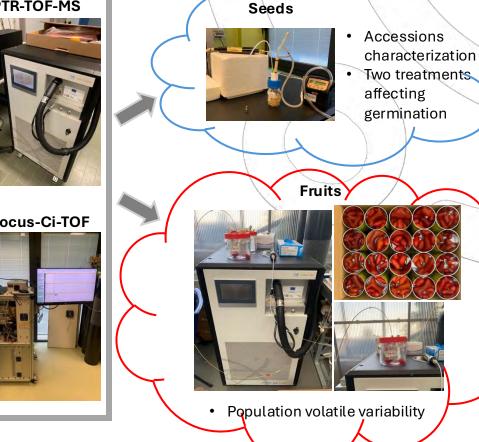
Upgrade the RIs by installing new instrumentations.

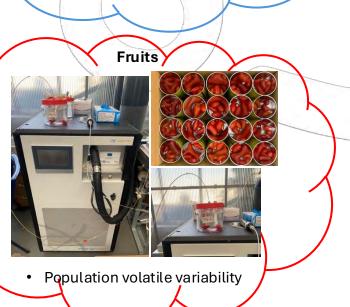
# Versatile applications of volatilome analysis across different @ITINERIS









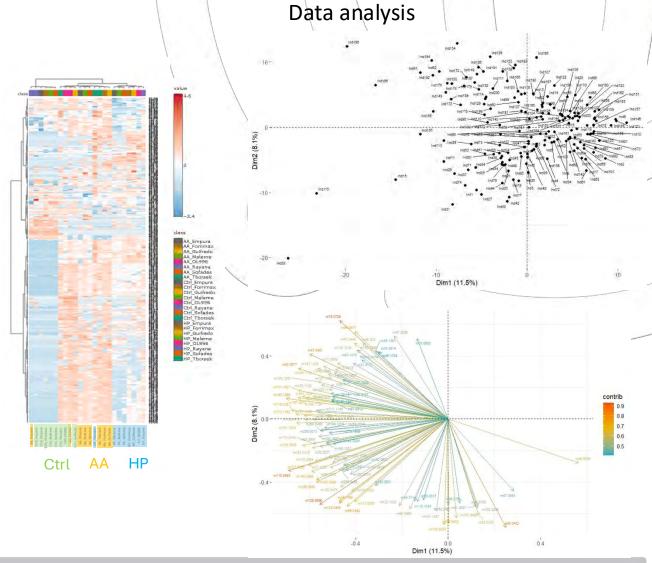


matrices

Versatile applications of volatilome analysis across different @ITINERIS
matrices

#### Data pre-processing

	A	В	C	D	E	F	G	H	1	J	K	L	M	N	0	P
1	Sample	Group	15.023	15.9938	17.0015	17.0256	18.0041	18.0335	18.954	18.9875	18.9993	19.0069	19.0116	19.0281	19.033	20.0233
2	Ctrl_Empura_1	Ctrl_Empura	1.39E-07	1.71E-08	0	0	1.46E-06	0	0	0	1.39E-05	0	0	1.49E-06	0	0
3	Ctrl_Empura_2	Ctrl_Empura	8.63E-08	2.92E-09	0	0	3.10E-07	0	0	0	1.21E-05	0	0	1.51E-06	0	0
4	Ctrl_Empura_3	Ctrl_Empura	4.09E-08	1.44E-08	0	0	2.95E-07	0	0	0	1.32E-05	0	0	1.56E-06	0	0
5	Ctrl_Empura_4	Ctrl_Empura	9.94E-08	1.06E-08	0	0	9.55E-07	0	0	0	1.34E-05	0	0	1.49E-06	0	0
6	Ctrl_Forrimax_1	Ctrl_Forrimax	5.69E-08	1.91E-08	0	0	2.45E-07	0	0	0	3.81E-05	8.26E-06	0.0001	0.00011	0	0
7	Ctrl_Forrimax_2	Ctrl_Forrimax	5.34E-08	3.34E-09	0	0	2.54E-07	0	0	0	4.19E-05	3.37E-05	0.0001	0.00011	0	0
8	Ctrl_Forrimax_3	Ctrl_Forrimax	3.96E-08	4.07E-08	0	0	2.66E-07	0	0	0	4.12E-05	2.29E-05	9.85E-05	0.00016	0	0
9	Ctrl_Forrimax_4	Ctrl_Forrimax	2.10E-08	1.46E-08	0	0	2.68E-07	0	0	0	4.34E-05	2.28E-05	9.54E-05	5.34E-05	0	0
10	Ctrl_Maleme_1	Ctrl_Maleme	9.71E-08	1.69E-08	0	0	1.40E-06	0	0	0	0	0.00011	0	0	0	0
11	Ctrl_Maleme_2	Ctrl_Maleme	9.48E-08	8.10E-09	0	0	1.53E-06	0	0	0	0	1.63E-05	0	0	0	0
12	Ctrl_Maleme_3	Ctrl_Maleme	1.33E-07	1.70E-08	0	0	1.40E-06	0	0	0	0	0.00021	0	0	0	0
13	Ctrl_Maleme_4	Ctrl_Maleme	1.12E-07	3.78E-08	0	0	1.42E-06	0	0	0	0	9.21E-05	0	0	0	0
14	Ctrl_Rayane_1	Ctrl_Rayane	1.02E-07	9.93E-09	0	0	1.10E-07	0	0	2.68E-06	9.27E-06	0	0	0	0	0
15	Ctrl_Rayane_2bis	Ctrl_Rayane	1.15E-07	1.11E-08	0	0	1.25E-07	0	0	1.12E-06	6.21E-05	0	0	0	0	0
16	Ctrl_Rayane_3	Ctrl_Rayane	4.45E-07	1.16E-08	0	0	4.02E-07	0	0	2.11E-07	6.57E-05	0	0	0	0	0
17	Ctrl Rayane 4	Ctrl Rayane	6.92E-07	1.15E-08	0	0	1.78E-06	0	0	6.51E-06	9.59E-05	0	0	0	0	0



# Versatile applications of volatilome analysis across different @ITINERIS matrices



#### Conclusions

- We collected VOC data from different matrices
- We implemented RI for VOCs detection



Maurilia Monti

**VOC Team** 

Michelina Ruocco



Francesco Loreto



Mauro Centritto



Liberata Gualtieri

Simona Gargiulo



Francesca Palomba



Mariachiara Cangemi





THANKS!











Aerosol classification: Results from a CNR-IMAA IOP (=intensive observation period)

Nikos Papagiannopoulos















# CNR-IMAA IOP/campaign



15 April – 1 May 2024



Primarily to study the Planetary Boundary Layer

+ to investigate aerosol typing.

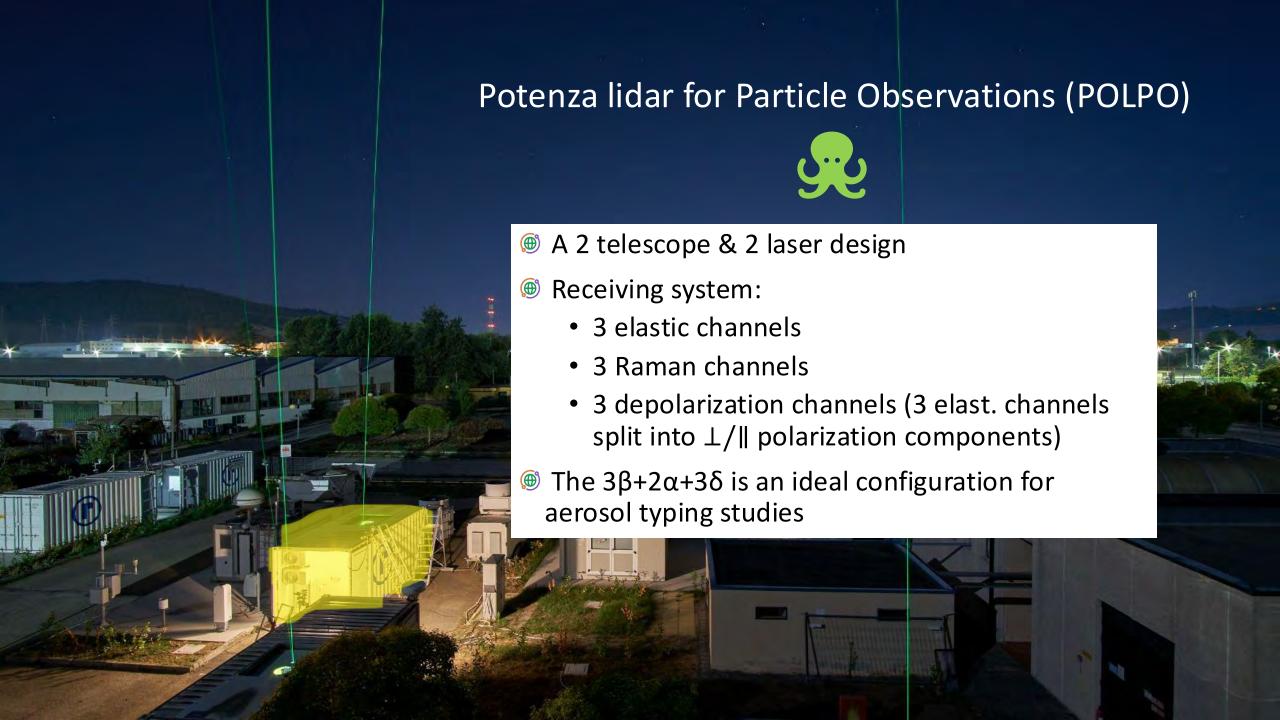


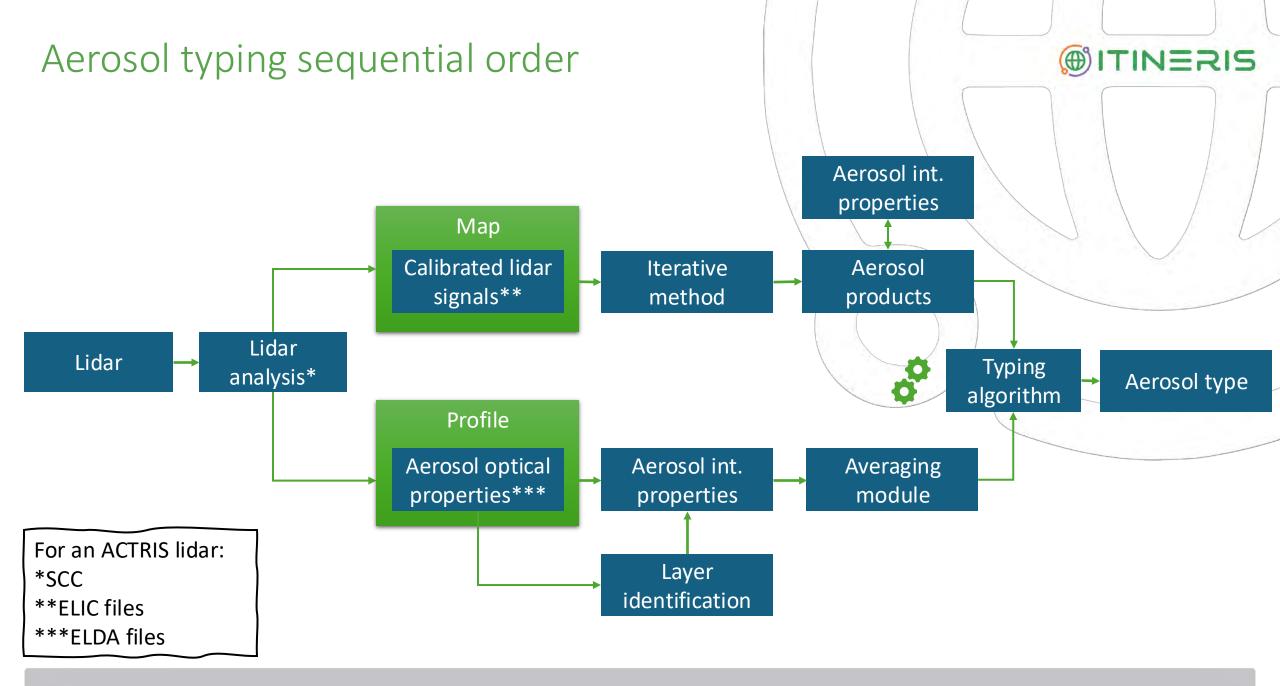


Using a multitude of instruments and techniques



(#)ITINERIS



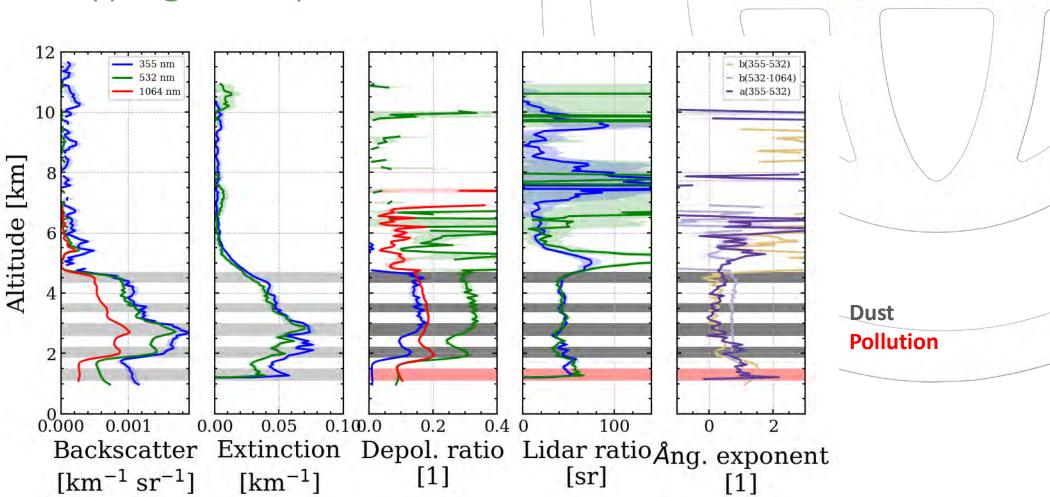


# Profile aerosol typing: methodologies



	NATALI	MAC	HETEAC-flex
Acronym	Neural Network Aerosol Typing Algorithm based on Lidar Data	Mahalanobis aerosol classification	Hybrid End-To-End Aerosol Classification – Flexible
Methodology	Relies on artificial neural networks	Based on the Mahalanobis distance classifier	Based on the optimal estimation method
Input	Aerosol optical properties	Layer-mean intensive properties	Layer-mean intensive properties
Configuration	$3\beta+2\alpha+1\delta$	$3\beta+2\alpha+1\delta$	$3\beta+2\alpha+2\delta$
Output	14 aerosol types	7 aerosol types	Mixtures of 4 aerosol types
Reference	Nicolae et al. 2018	Papagiannopoulos et al. 2018	Floutsi et al. 2023

## Profile aerosol typing: example



(#) ITINERIS

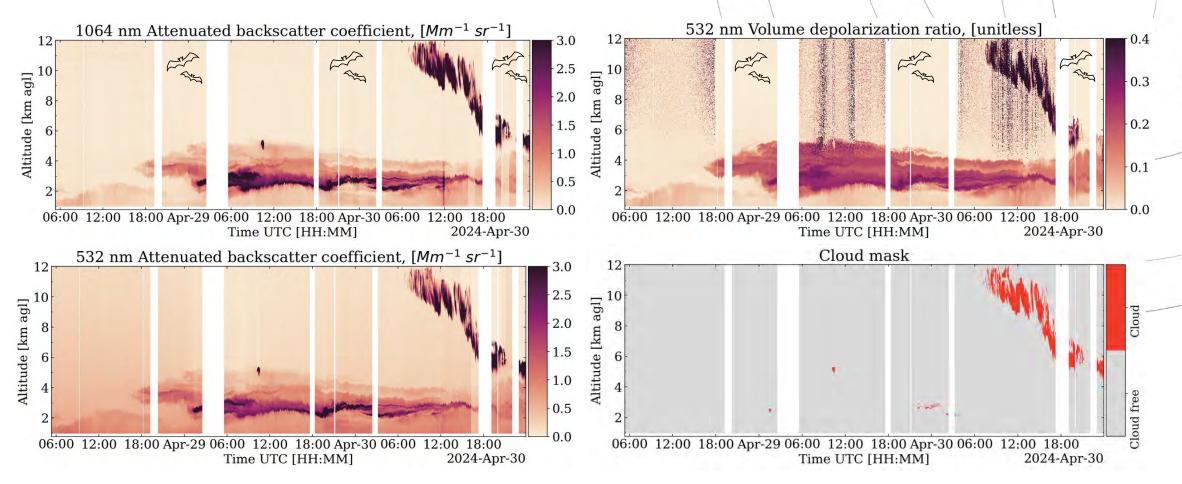
### Study period:

## 28 April 05:20 UTC – 30 April 23:56 UTC



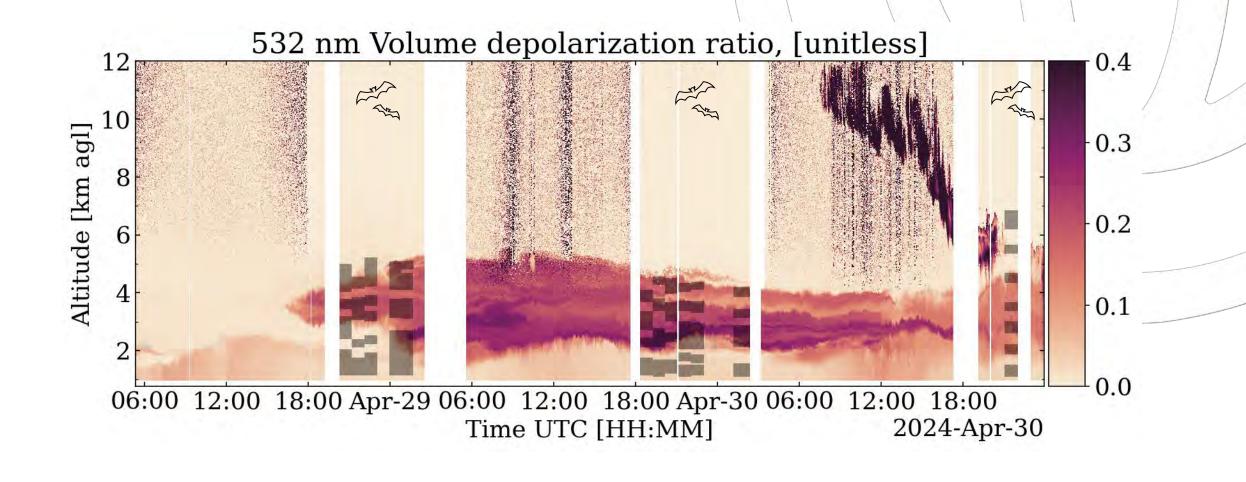


#### : nighttime operation



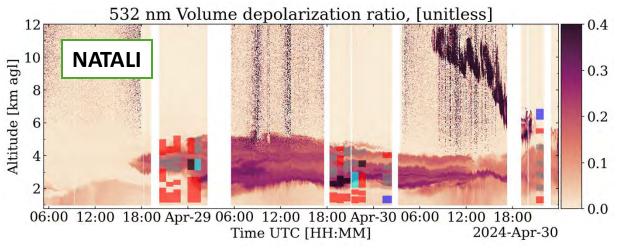
# Profile aerosol typing: layers





## Profile aerosol typing





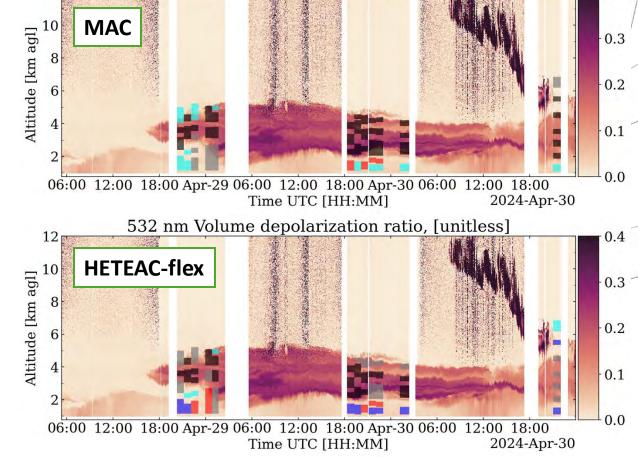


**Dust mixtures** 

**Pollution** 

Sea salt

Not typed



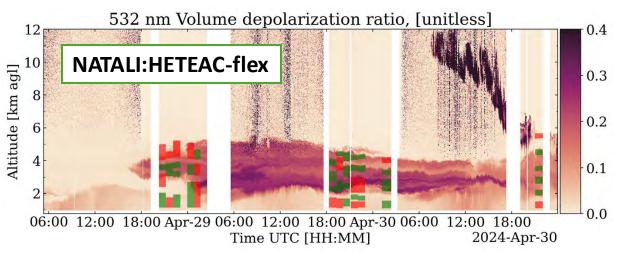
532 nm Volume depolarization ratio, [unitless]

ITINERIS

0.4

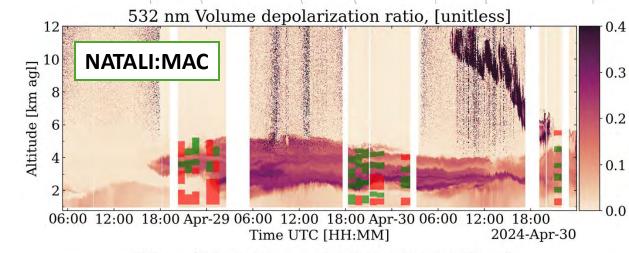
# Profile aerosol typing: performance

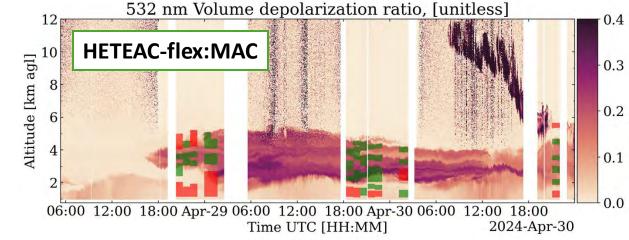




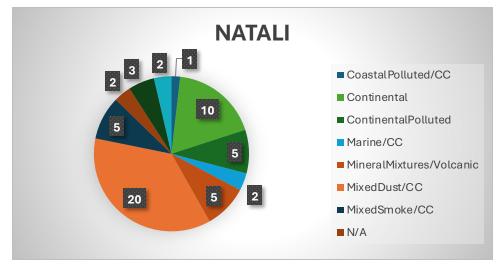


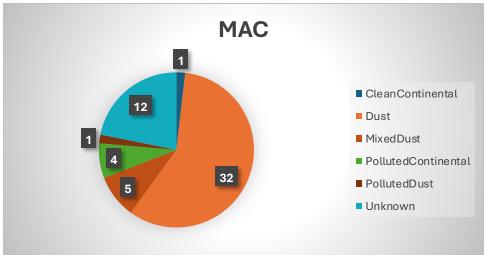
	Natali:HETEAC	NATALI:MAC	HETEAC:MAC
Agreement	61%	52%	80%
Disagreement	39%	48%	20%

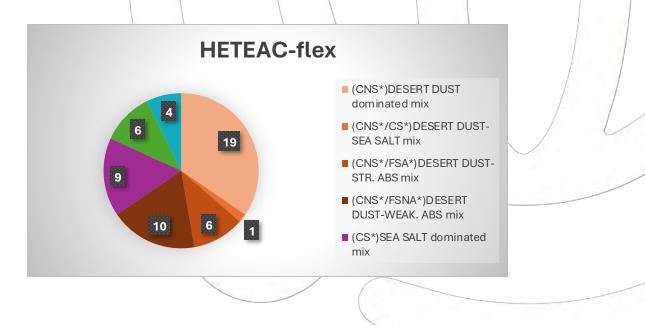




# Profile aerosol typing: summary







(#) ITINERIS

Orange hues indicate dusty aerosol types

Annual meeting – Rome – 9-10/07/2024

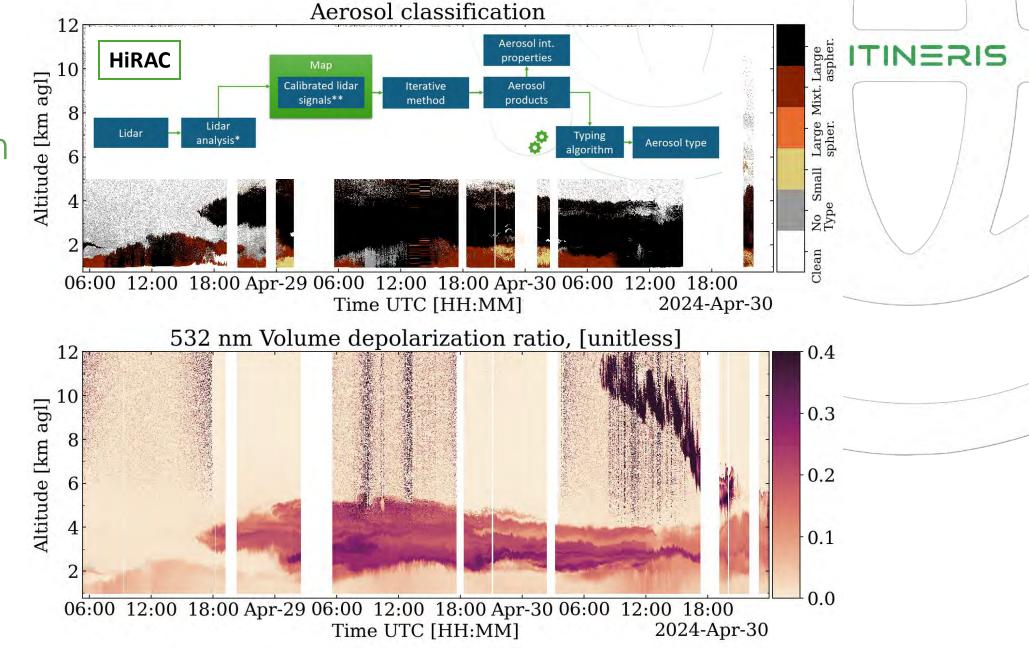
# Map aerosol typing: methodology

	HiRAC			
Acronym	High resolution aerosol classification			
Methodology	Threshold based			
Input	Aerosol optical and intensive properties			
Configuration	2β+1δ			
Output	4 aerosol types			
Reference	Baars et al. 2017 Papagiannopoulos et al. 2020			



Annual meeting – Rome – 9-10/07/2024

Map aerosol classification



#### Conclusions



- The CNR-IMAA campaign provided the perfect environment for aerosol typing as shown today and will allow for a more exhaustive analysis given the participating instruments
- In particular, 4 (3 low and 1 high temporal resolution) aerosol typing algorithms have been fine-tuned to accept ACTRIS-like lidar data
- A dedicated server partly hosts, as of today, the abovementioned algorithms and their output with the goal to become the centerpiece of this task



# THANKS!













ITINERIS geophysical technologies @CNR-IREA: drone-based tests at Altopiano di Verteglia, Avellino (Southern Italy)

Andrea Barone, Research Technologist – WP7, Task 7.5

barone.a@irea.cnr.it









#### Test site: the karst plane of the Altopiano di Verteglia (Montella, AV)



Pyroclastic Deposits

Highly Fissured Limestone

Fissured Limestone





1178 1175

1174



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# Tested Instrumentation & Performed Survey (1/2)



Flight Lines



#### MagNimbus

Magnetometric system equipped with 2 QuSpin Gen-2 sensors for the measurement of the total magnetic field and its vertical gradient.

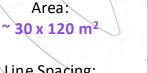




- Sampling rate: from 200 to 1000 Hz
- Sensitivity: 0.003 nT
- Weight: 1.5 kg
- Distance between sensors: 1.7 m
- Distance sensors and drone: 1 and 0.5 m
- Maximum flight speed: 4 m/s
- Output format: \*.csv
- Powered by: drone batteries
- Data collection: via SkyHub
- Used drone: DJI M300 RTK



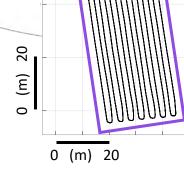
Magnetometric Survey



Line Spacing: 2 m

Sensors Altitude:

Flight Speed: 2 m/s



The magnetometric method allows the detection of the magnetization contrasts related to shallow and deep sources.

# Tested Instrumentation & Performed Survey (2/2)



Flight Lines



#### Zond Aero LF

Ground Penetrating Radar (GPR) system equipped with 3 unshielded dipole antennas of different frequency.



- Antenna Frequency: 100, 150, 300 MHz
- Time range for sample: from 18 ps
- Number of sample: up to 8192
- Weight: from 0.9 to 1.2 kg
- Maximum detection depth: ~10 m
- Output format: \*.sgy
- <u>Powered by</u>: drone (or external) batteries
- <u>Data collection</u>: via Ethernet
- Used drone: DJI M300 RTK



**GPR Survey** 

Area:

10 x 40 m<sup>2</sup>

Antenna Frequency:

300 MHz

Line Spacing:

0.5 m

Flight Altitude:

1.5 m

Flight Speed:

1 m/s

(E) 0 (m) 4

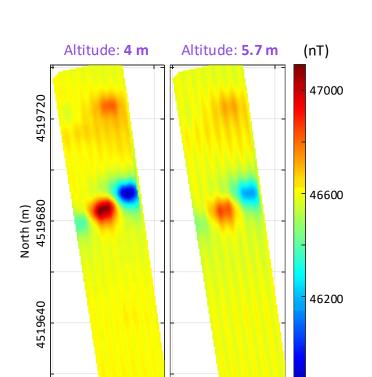


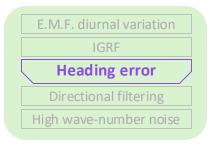
The GPR method allows the detection of the electric permittivity contrasts.

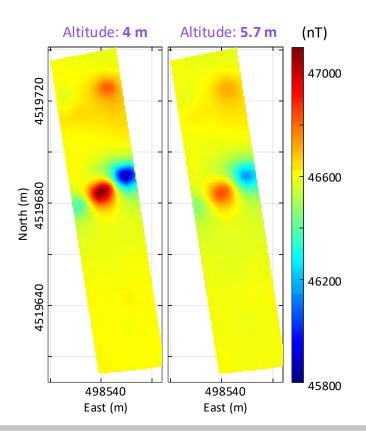
# Collected data & Processing – Magnetometric Method

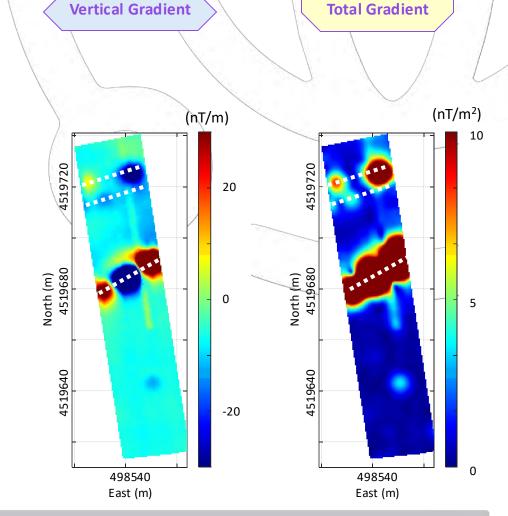


Total magnetic field measurements









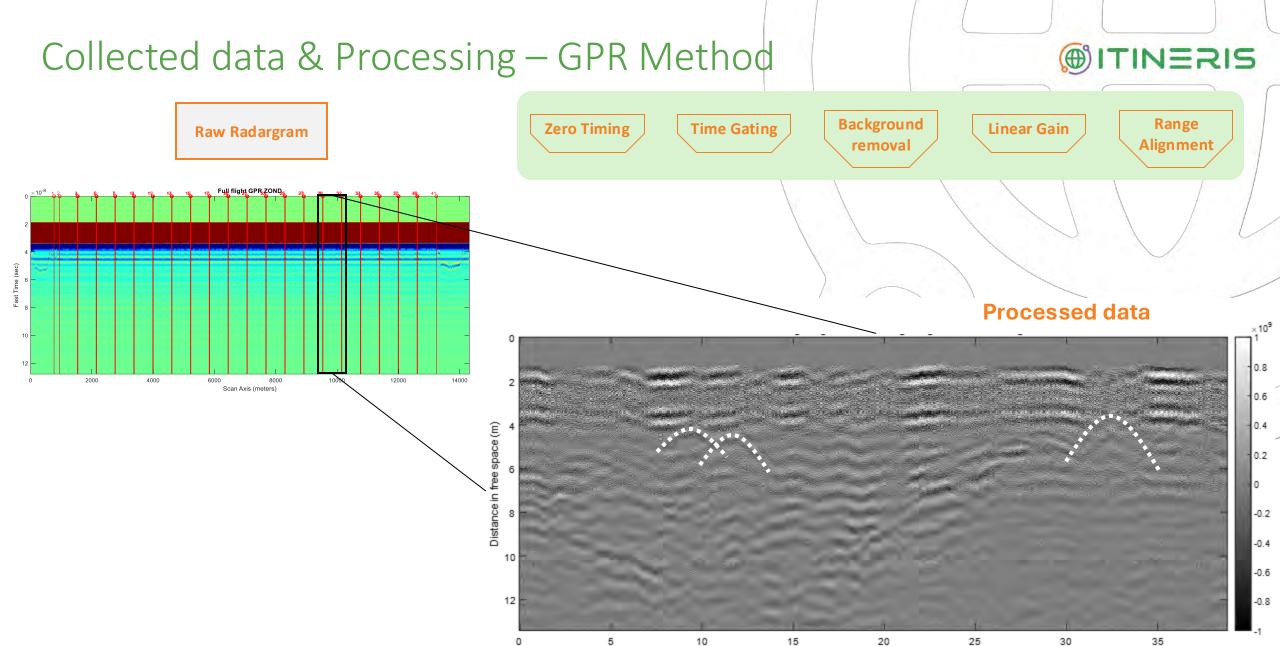
498540

East (m)

498540

East (m)

45800



Distance (m)

#### Conclusions & Future Activities



- The preliminary UAV-based tests have been successful for the detection of buried pipes
- The performed processing has enhanced the signal contributions related to the detected targets

- Data collection tests:
  - Line Spacing
  - Flight Altitude
  - Single Sensor
  - Antenna Frequency

- Comparison of data collected by other Instrumentations
- Testing Instrumentations for other targets detection
- Testing Source Modeling Methods

- Ground-based Instrumentations Tests:
  - Magnetometer in vertical gradiometer configuration (**G-864**)
  - Electromagnetometer (CMD Explorer 6L)
  - Georadar (Geoscope MklV)



# THANKS!





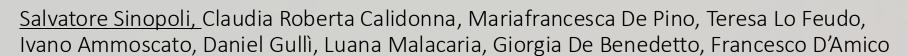








Methods for selection and integration of background data in forest fires emission



CNR-ISAC Lamezia Terme









#### The context of the WP4.16

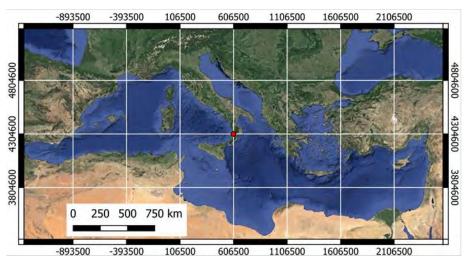
#### (#)ITINERIS

# What are we approaching ??

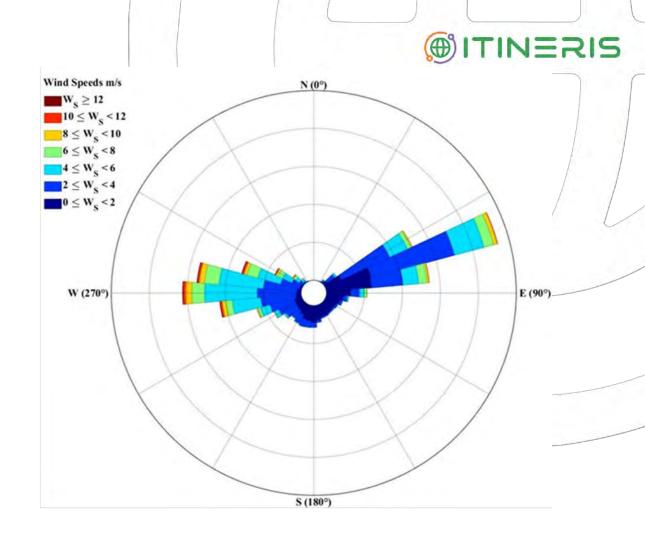
- Wildfires develop plumes of emission in the atmosphere;
- The plumes are composed by different species of gases and aerosol;
- The products of fire events can travel for hundreds or thousands of kilometers;



# Geographical Context







The LMT site is located in the middle of the Mediterranean Sea, into the channel of the two sea. The area is characterized by persistent and regular winds.

# Materials for the analysis



#### In situ sampler













Green House Gas

Black Carbon

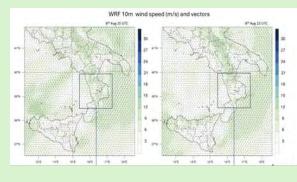
**Ozone** 

NOx

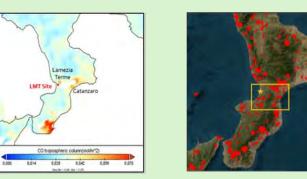
Particles Counter

Particles Samples

#### Spatial data



**Models Products** 



**Satellite Products** 

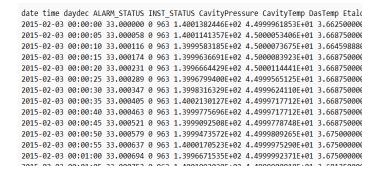


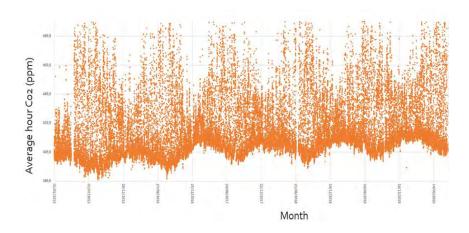
**Local Register** 

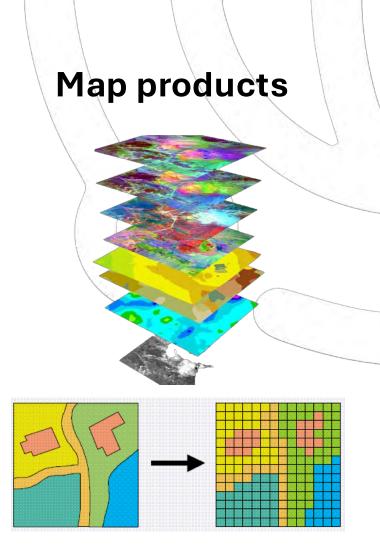
# Type of available data

#### **Samplers**

Here data refers only to a single point, with a very high level of precision and accuracy.







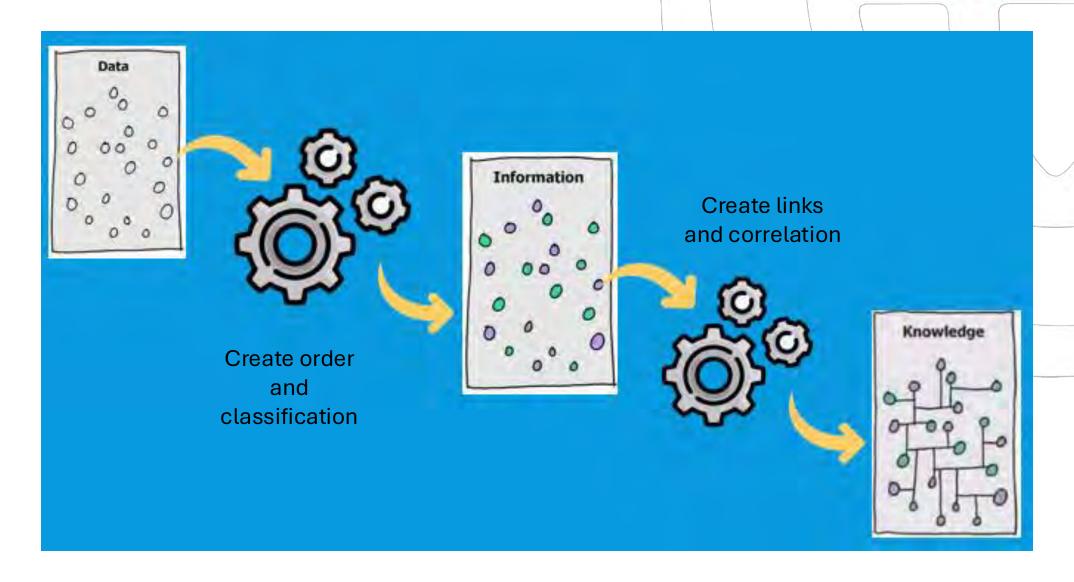
Here data covers an area (some square kilometers) with loss of detail, due to the pixel resolution of the specific

ITINERIS

product.

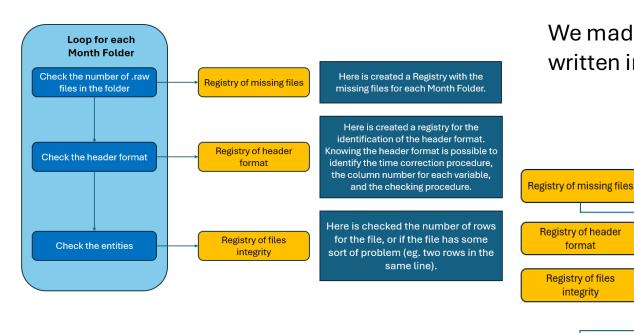
# The process that need to be built





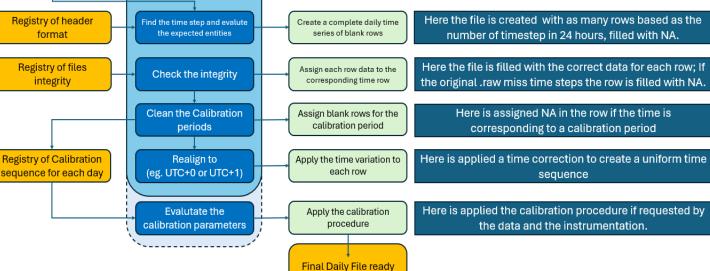
#### The «informatic» steps – look for problems in data ... and apply solutions





We made a series of script to find anomalies in data written in the files, and check every single entry ...

Loop for each daily



for the analysis

... after we made a series of script to reorder data in simple way, to made an easier aggregation of data coming from different samplers.

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To the Folder of the

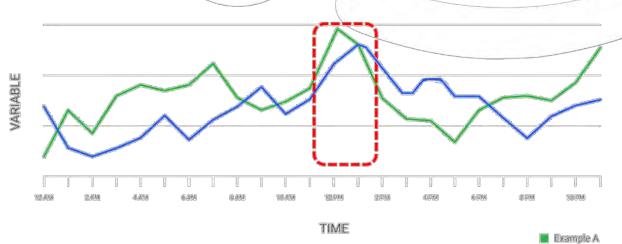
processed Files

#### Find a «pattern» in the data and classify them



LMT h	date	time	Vaisala ent num	wind speed	wind speed std	wind direction	wind direction std	Picarro ent num	CO val	CO std	MAAP ent num	BC mass	BC mass std
1	01/01/2015	00:00:00	60	1,59	0,73	106,35	28,49	720	343,79	23,93	60	1,46	0,19
2	01/01/2015	01:00:00	60	3,56	1,35	72,5	18,28	720	291,10	28,64	60	1,09	0,21
3	01/01/2015	02:00:00	60	4,42	1,03	64,08	8,04	720	295,63	45,25	60	0,44	0,24
4	01/01/2015	03:00:00	60	3,87	1,16	62,18	45,4	720	223,18	13,59	60	0,27	0,08
5	01/01/2015	04:00:00	60	3,15	1,45	70,37	126,26	720	209,59	8,88	60	0,29	0,09
6	01/01/2015	05:00:00	60	1,53	0,72	143,77	157,51	720	204,65	18,92	60	0,30	0,09
7	01/01/2015	06:00:00	60	2,12	0,78	213,7	146,42	720	190,05	19,94	60	0,26	0,10
8	01/01/2015	07:00:00	60	2,69	0,96	260,25	138,68	720	192,26	23,99	60	0,33	0,11
9	01/01/2015	08:00:00	60	2,63	0,74	311,92	82,1	720	199,04	28,39	60	0,40	0,11
10	01/01/2015	09:00:00	60	3,01	0,8	277,62	134,62	720	190,73	24,96	60	0,38	0,11
11	01/01/2015	10:00:00	60	4,09	1,18	33,97	74,94	720	204,18	27,61	60	0,39	0,11
12	01/01/2015	11:00:00	60	4,8	0,92	70,7	119,91	720	232,13	10,44	54	0,45	0,13
13	01/01/2015	12:00:00	60	4,69	0,88	38,43	74,19	720	213,61	7,98	60	0,34	0,03
14	01/01/2015	13:00:00	60	4,51	0,98	41,55	85,34	720	218,71	4,90	60	0,38	0,02
15	01/01/2015	14:00:00	60	3,94	0,96	94,18	150,71	720	218,73	8,49	60	0,38	0,04
16	01/01/2015	15:00:00	60	4,16	1,05	48,68	13,82	720	223,89	14,26	60	0,47	0,03
17	01/01/2015	16:00:00	60	2,47	0,5	65,3	11,48	720	231,28	5,38	60	0,47	0,05
18	01/01/2015	17:00:00	60	2,96	0,55	74,4	7,92	720	252,11	12,58	60	0,77	0,13

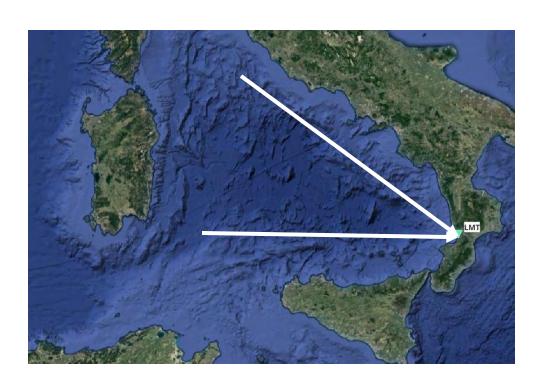
With a perfectly ordered
Database it's easier the
identification of
"anomalies" in different
data at the dame time.

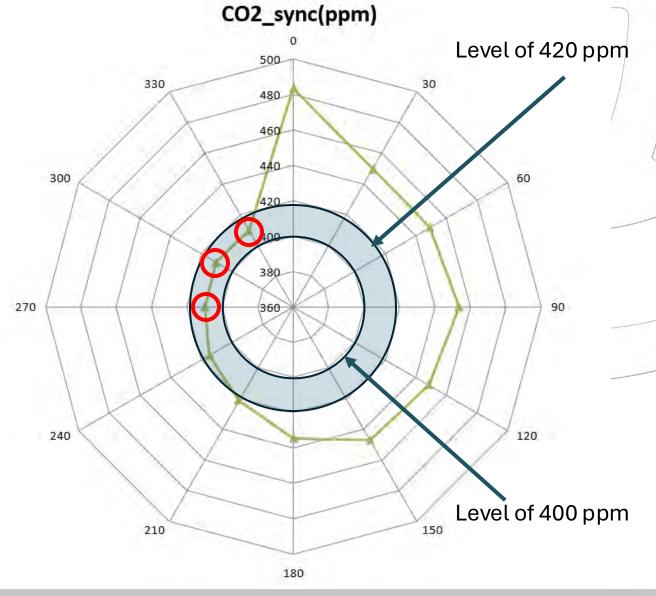


### Site experience – Wind from the sea



The reconstruction of the data show that the correlation of Wind Direction and CO2 level coming from W-NW are around 410 ppm.

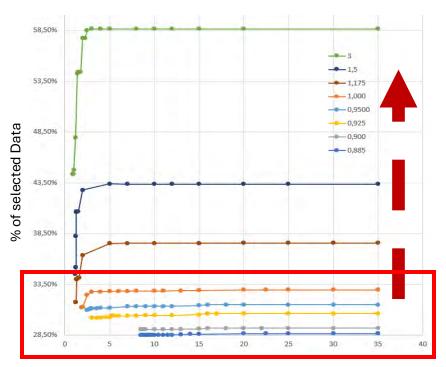




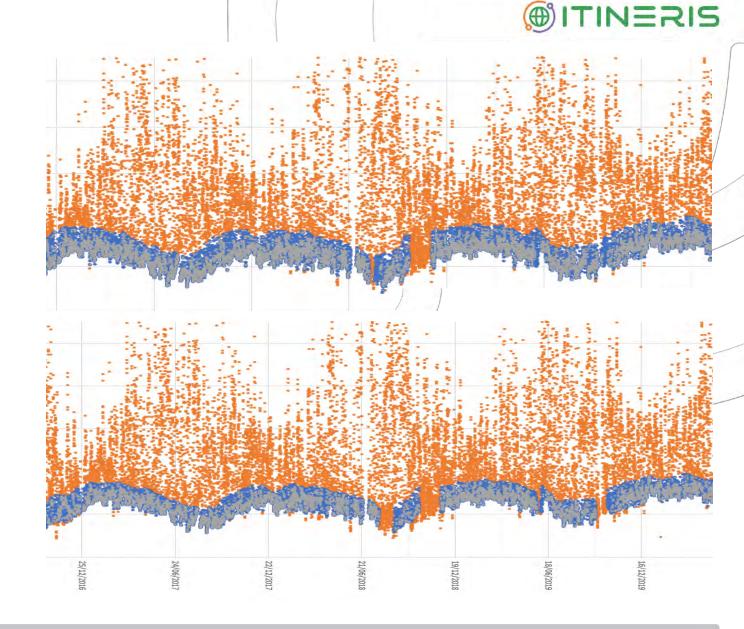
#### A statistical blind method

Based on the fluctuations of Mean value and Standard Deviation.

Can be "tuned" in the parameters to select more or less data. So it's not total blind.



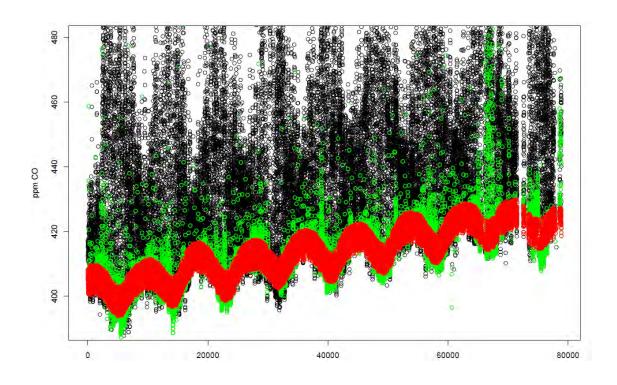
Growth of Sub-hour fluctation (STD tolerance)

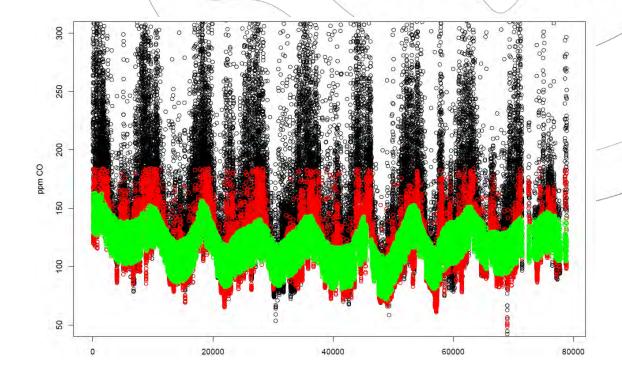


## A graphical comparison of the methods ICOS\_LMT\_SITE\_CO2



ICOS\_LMT\_SITE\_CO





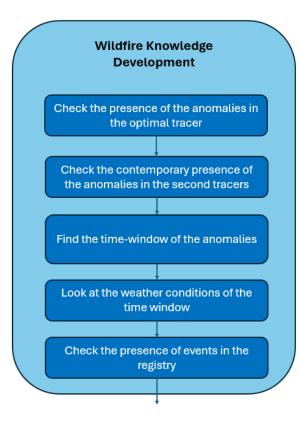
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#### Results



#### The Methodology

#### The case study

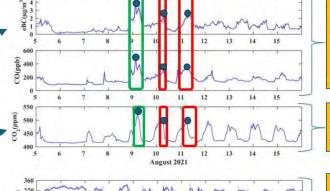


Mark the start and end of the anomaly in the Registry of Anomaly for tracers\_1

Mark the start and end of the anomaly in the Registry of Anomaly for tracers\_2

Try to identify a direction and velocity of air masses

Try to identify the presence and location of a contemporary emission source



The spikes represents the anomalies. Marked anomalies are used to find the time-window

Find anomalies in the secondary tracers helps in confirmation of events

The contemporary wind direction suggest where to look for the source

Looking at the local circulation asses the trajectory of the air mass

The presence of sources (multiple in this case) can validate the procedure

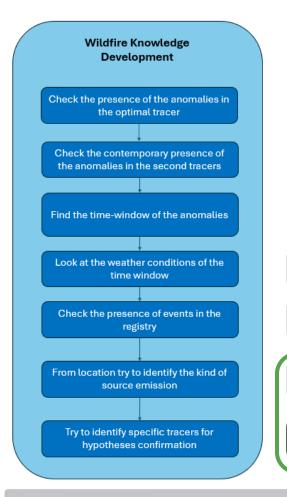
Future steps

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17

#### Future development

#### The Methodology development



Mark the start and end of the anomaly in the Registry of Anomaly for tracers\_1

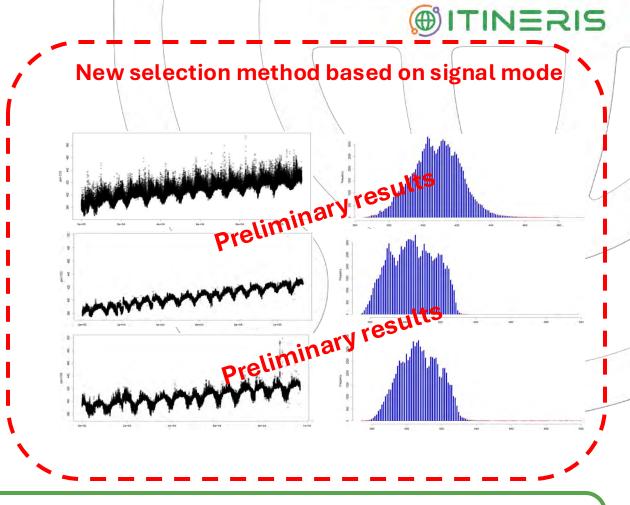
Mark the start and end of the anomaly in the Registry of Anomaly for tracers\_2

Try to identify a direction and velocity of air masses

Try to identify the presence and location of a contemporary emission source

Try to identify if is a forest fire or urban fire

Look at isotopes samplet, dust analysis



We will add isotope analysis and offline analysis to specify the source



## THANKS!

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# Overview on ABL height measurement campaign at CIAO observatory

Giuseppe D'Amico, Aldo Amodeo, Davide Amodio, Francesco Cardellicchio, Benedetto De Rosa, Nicola Gianluca Di Fiore, <u>Ilaria Gandolfi</u>, Aldo Giunta, Emilio Lapenna, Teresa Laurita, Fabrizio Marra, Michail Mytilinaios, Lucia Mona, Nikolaos Papagiannopoulos, Serena Trippetta, Marco Rosoldi, Donato Summa, Gemine Vivone, Canio Colangelo

**CNR-IMAA** 





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#### CIAO ABLH Campaign's goals



- Walidation and optimization of MIPA (Morphological Image Processing Approach) algorithm for the detection of the ABL height
- Provide frequent radio sounding to have dense reference dataset for MIPA
- Evaluate the applicability of MIPA on LPL (ceilometers)
- Perform ABL measurements with different sensors (in order to investigate the limit of single sensors)
- Establish an extensive dataset to test any ABLH retrieval
- Investigate the better approach to detect ABLH and more in general to characterize ABL processes using both single sensor and synergetic observations

#### Secondary goals:

- Calibrate new CIAO instruments (especially temperature and water vapor lidar vertical profiles retrieved by new lidar)
- Characterize interesting case studies using observations from all CIAO sensors
- Study the correlation between ABL properties retrieved by remote sensor instrument and observation made by insitu instrument at ground

### Observatory instrumentations







Sensor type	Instrument	Main Products			
	Fixed Multi-wavelength Raman Lidar (POLPO)	Aerosol Backscatter @1064, 532 and 355 nm Aerosol Depolarization ratio @1064,532 and 355 nm Aerosol extinction @532 and 355 nm			
LIDI	Mobile Multi-wavelength Raman Lidar (MEDUSA)	Aerosol Backscatter @1064, 532 and 355 nm Aerosol Depolarization ratio @1064,532 and 355 nm Aerosol extinction @532 and 355 nm			
HPL	MUSA	Aerosol Backscatter @1064, 532 and 355 nm Aerosol Depolarization ratio @ 532 nm Aerosol extinction @532 and 355 nm			
	Mobile Multi-wavelength Raman Lidar (CONCERNING) UniBas	Aerosol Backscatter, Aerosol Depolarization ratio, Aerosol extinction, Water vapor, Temperature, CO2 @355 nm			

### Observatory instrumentations

Sensor type	Instrument	Main Products			
	MIRA36 (35 GHz)	Doppler Spectrum Doppler velocity Linear Depolarization ratio			
Doppler Radar	Halo Photonics Stream Li neXR (1.5 μm)	Aerosol/cloud Backscatter Particles' radial velocity Air masses vertical and horizontal velocity			
	CL51 (905 nm)	Aerosol backscatter Cloud base height			
LPL	CL31 (905 nm)	Aerosol backscatter Cloud base height			
	CHM 15 k (1064 nm)	Aerosol backscatter Cloud base height			
Microwave Radiometer RPG-HATPRO-G5		Temperature, humidity and cloud liquid water profiles Integrated Precipitable Water Vapour (IPWV) Cloud Liquid water Path(LWP			









### Observatory instrumentations



Sensor type	Instrument	Main Products		
Dadiacounding overen	MW41 (Manual)	Temperature, pressure and humidity		
Radiosounding system	AS13 (automatic)	Temperature, pressure and humidity		





#### Observatory Instrumentation

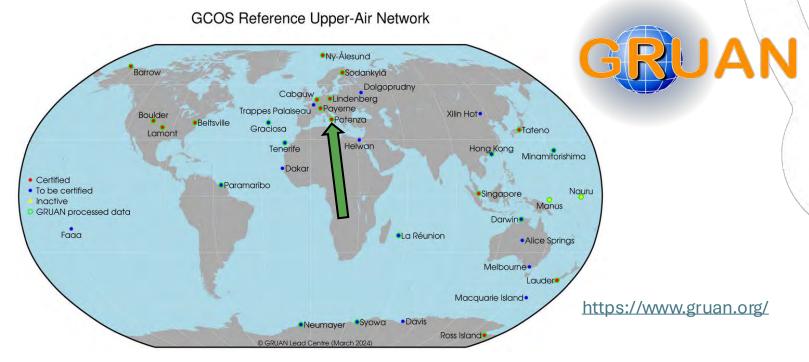
Sensor type	Instrument	Main Products			
	Aethalometer AE33	Absorption coefficient and equivalent Black Carbon (eBC) concentration			
	Nephelometer Au rora 3000	Scattering and back scattering coefficient			
	Aerodynamic Particle Size APS 3321	Particle size distribution (0.5-20 μm)			
In situ	Condensation Particle Counter (CPC 3750)	Particle number concentration (>10 nm)			
	Scanning Mobility Particle Sizer (SMPS 3938)	Size distribution and concentration (10-800 nm)			
	ToF-ACSM	Chemical composition and mass concentration of non-refractory aerosol (<1µm)			
	PMx Samplers	PM10, PM2.5, PM1 concentration			



#### Planning the campaign



The CIAO ABLH measurement campaign took place at CNR-IMAA (40.60N, 15.72E, 760 m a.s.l.) from 15 April 2024 up to 1 May 2024.



CIAO observatory is equipped with two radiosounding systems (one of which with an automatic launcher) which are part of GCOS Reference Upper Air Network (GRUAN).

The exact scheduling of the radiosondes' launches has been evaluated case by case based on high-resolution weather model forecasts, with denser launches typically performed in correspondence of ABL transition periods or during special events like dust intrusions.

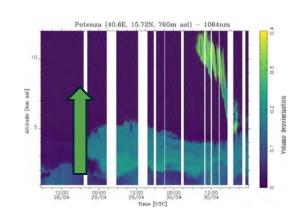
#### MIPA algorithm



The MIPA algorithm (Morphological Image Processing Approach) was developed at the CNR-IMAA as part of ACTRIS and has already been tested on several HPL datasets, showing excellent performance compared to traditional ABLH retrieval techniques

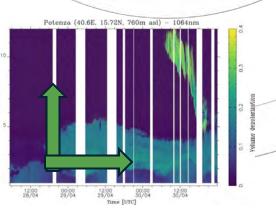
The innovation of MIPA consists in operating on time series of lidar profiles and not on a single lidar profile (as most of the ABLH retrievals based on literature do).

Traditional ABLH retrieval techniques from HPL datasets consider the vertical dynamics of individual lidar profiles.



#### **MIPA**

It considers the vertical dynamics of individual lidar profiles. It considers the correlation between contiguous lidar observations over time.



This feature makes MIPA a robust algorithm and opens the possibility of extending its applicability to a large number of lidar systems with different characteristics in terms of signal-to-noise ratio.

#### Case studies selection's



We selected two case studies which represent the longest and almost continuous HPL observations available during the whole campaign:

17 radiosoundings and 69 hours of almost continuous HPL observations made by POLPO.

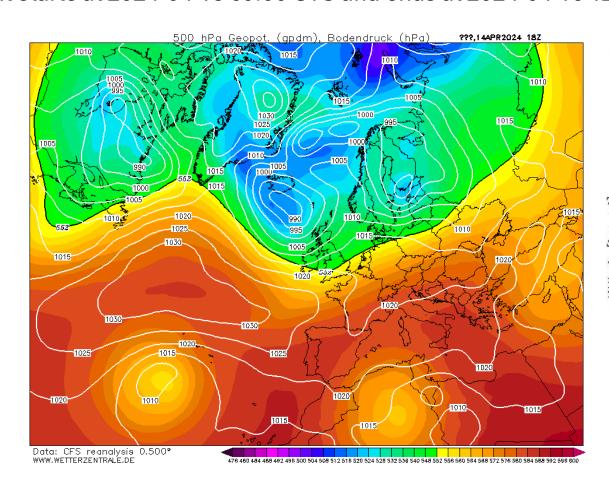
© Case study 2: from 2024-04-15 00:00 UTC up to 2024-04-16 12:00 UTC

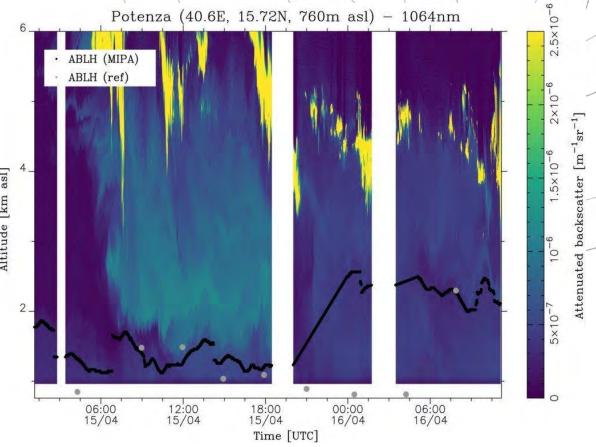
9 Radiosoundings and 36 hours of almost continuous HPL observations made by POLPO

#### Case Study 15-16 April



This case study includes 36 hours of almost continuous HPL observations made by POLPO. It starts at 2024-04-15 00:00 UTC and ends at 2024-04-16 12:00 UTC.

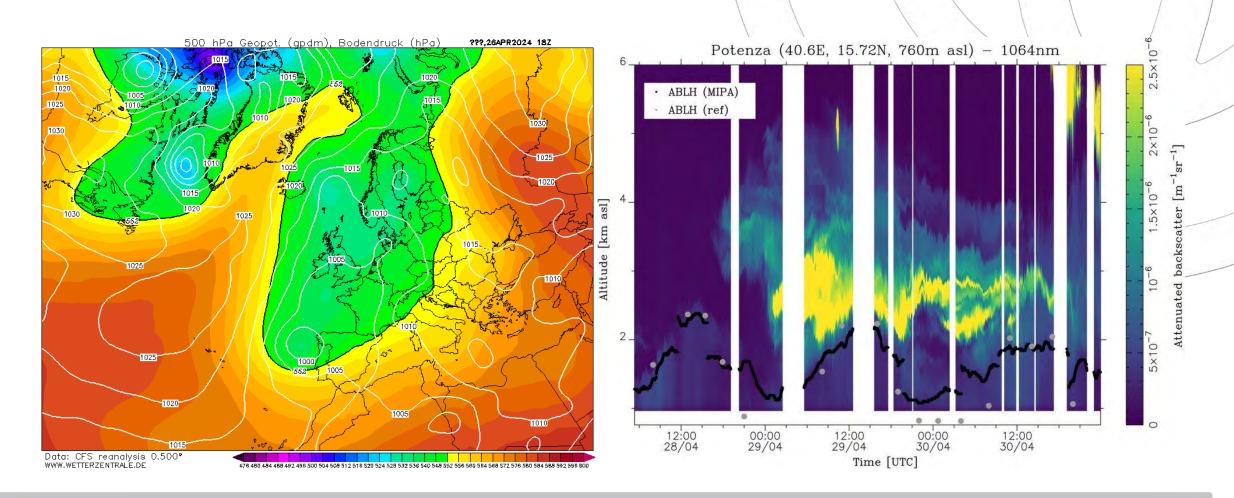




#### Case Study 28 April - 01 May



This case study includes 69 hours of almost continuous HPL observations made by POLPO. It starts at 2024-04-28 03:00 UTC and ends at 2024-05-01 00:00 UTC because of incoming low rain clouds



#### Conclusions and future steps

	All reference points	Only reference points above lidar full overlap height
$\Delta_{\text{mean}}[m]$	365	151
$\Delta_{\mathrm{med}}$ [m]	240	116
$\Delta_{\mathrm{SD}}\left[\mathrm{m}\right]$	434	105
$\Delta_{\mathrm{SE}}\left[\mathrm{m} ight]$	85	26
$\Delta_{\min}\left[m\right]$	16	16
$\Delta_{\text{max}}$ [m]	1750	373
N	26	16

There are also other algorithms in the literature that calculate ABLH using a temporal correlation. However, the number of radiosoundings carried out in a short time periods, represents the uniqueness of this study



#### 1.MIPA

- 2. Instrumental limitations (ABLH lower than the lidar overlap)
- 3.Different definitions of ABLH (thermodynamics in the case of the reference set, based on aerosols as tracers of the ABL in the case of the lidar dataset).

The optimized configuration of MIPA that we use can recover ABLH with an average error of 150 m in all cases where lidar observations allow capturing the ABLH.

#### The next goals of the campaign will be:

- Evaluation of the optimized MIPA configuration on all data sets of the HPL measurement campaign also at shorter wavelengths (355, 532).
- Evaluation of the optimized MIPA configuration on the ceilometer measurement campaign datasets (LPL).
- Evaluation of the ABLH using a multisensor approach.

#### Link with projects and infrastructures



This dataset and the evaluation of ABL Height is propedeutic to:

GRUAN products, calculation of ABLH and it's uncertainty

®Ri-Urbans: Pilot services for air quality quality project



https://riurbans.eu/



https://ciao.imaa.cnr.it

THANKS!

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## CIAO – CNR – IMAA Atmospheric Observatory: first aerosol in-situ measurements in conjunction with aerosol profiling

<u>Teresa Laurita</u>, A. Mauceri, F. Cardellicchio, E. Lapenna, B. De Rosa, S. Trippetta, M. Mytilinaios, D. Amodio, A. Giunta, E. Ripepi, C. Colangelo, N. Papagiannopoulos, F. Morrongiello, C. Dema, S. Gagliardi, C. Cornacchia, R. M. Petracca Altieri, A. Amodeo, M. Rosoldi, D. Summa, G. Pappalardo, L. Mona

teresa.laurita@cnr.it

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#### CIAO-CNR-IMAA Atmospheric Observatory



@ The CIAO observatory represents, since 2000, one of the largest ground-based remote-sensing station in the Mediterranean Basin for the study of aerosol, water vapour and clouds.











**Cloud Remote Sensing** – since 2005

**Aerosol Remote Sensing** – since 2000





**Trace gases Remote Senting** in implementation



Aerosol in-situ – since 2024



Radiosounding – since 2000

#### Aerosol in-situ National Facility



The new aerosol in-situ facility at CIAO has received initial acceptance as ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure) National Facility observational platform in February 2024 for the measurements of the obligatory ACTRIS aerosol in-situ physical and chemical variables:



Particle number concentration > 10 nm (CPC)

Particle number size distribution – aerodynamic diameter 800 nm to 10 μm (APS)

Particle number size distribution – mobility diameter 10 to 800 nm (SMPS) Particle light scattering & backscattering coefficient (Nephelometer)

Particle light absorption coefficient and equivalent black carbon concentration (Aethalometer)

Particle chemical elemental composition (ToF-ACSM, ICP-OES, OC/EC Analyzer)



Laurita et al., CIAO observatory main upgrade: building up an ACTRIS compliant aerosol in-situ laboratory, Atmos. Meas. Tech. Discuss. [preprint], https://doi.org/10.5194/amt-2024-57, in review, 2024.



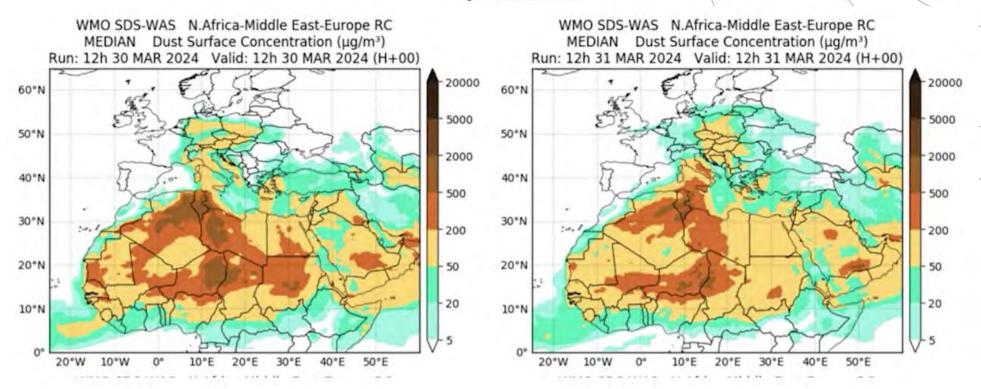
In situ measurements in conjunction with aerosol profiling will be important for studying aerosol properties, especially for special cases like desert dust and biomass burning, events that typically occur in the CIAO site during spring/summer.

## First aerosol in-situ measurements in conjunction with aerosol profiling









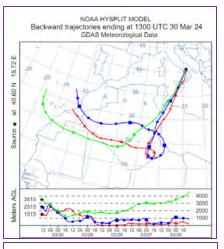
### First aerosol in-situ measurements in conjunction with aerosol profiling

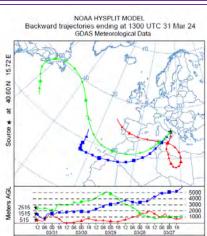




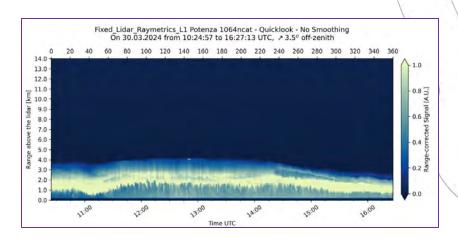
African dust instrusion at CIAO Observatory on 30 – 31 March 2024

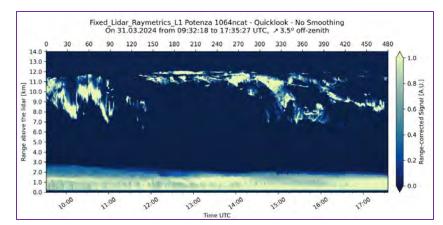
#### HYSPLIT backward trajectory

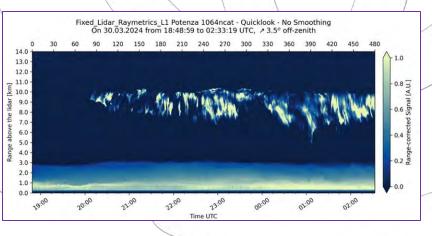


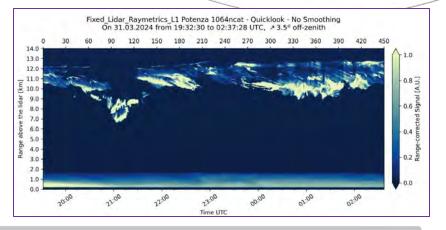


Lidar – Potenza – Lidar signal @1064nm









## First aerosol in-situ measurements in conjunction with aerosol profiling

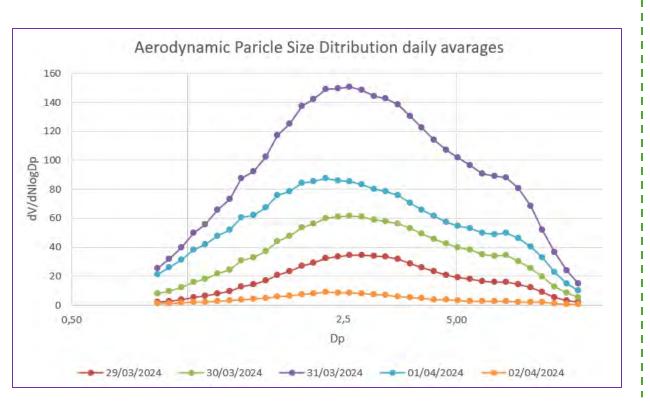




African dust instrusion at CIAO Observatory on 30 – 31 March 2024 – in-situ measurements



APS spectrometer provides real-time aerodynamic measurements for the coarse fraction of the particle in the size range from 0.8 to 10  $\mu m$  and plays a key role during dust intrusion



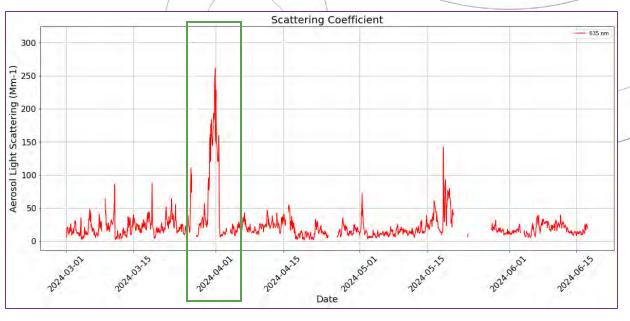


**Nephelometer** measures the total scattering  $(\sigma_{sp})$  and the backscattering  $(\sigma_{bsp})$  coefficients at three distinct wavelengths:

635 nm (red) interacts strongly with large particulate matter;

525 nm (green) interacts strongly throughout the human range of visibility;

450 nm (blue) interacts strongly with fine and ultrafine particulates



#### Future Perspectives



- ✓ investigation of aerosol characteristics at the ground for special events like desert dust and biomass burning as identified by remote sensing measurements using multiple in situ instruments, with a focus on chemical analysis
- ✓ characterization of the typical aerosol chemical and dimensional properties at CIAO
- ✓ enhancement of aerosol typing methods developed by CIAO team
- ✓ better understanding of processes of vertical transport of the particles to the surface



## THANKS!

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Soil-building resonance effect in the urban area of the city of Potenza (Southern Italy)

Analysis of resonance frequencies using the HVSR technique

Phd Student: Giovanni Gangone

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"







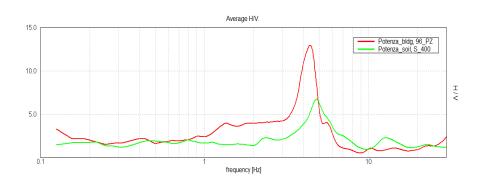




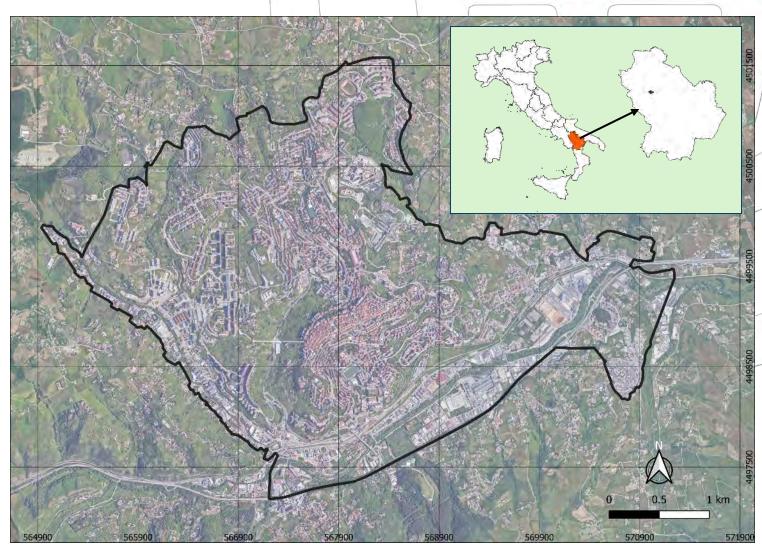
#### Introduction



In the event of an earthquake, when the resonance frequencies of the soil are close to those of the building, the structure may experience particularly severe stress conditions, potentially leading to increased damage. The analysis technique used to experimentally define the frequency content of the energy emitted by a seismic source, and its transfer to the site, involves recording environmental seismic noise signals using the Horizontal-to-Vertical Spectral Ratio (HVSR).

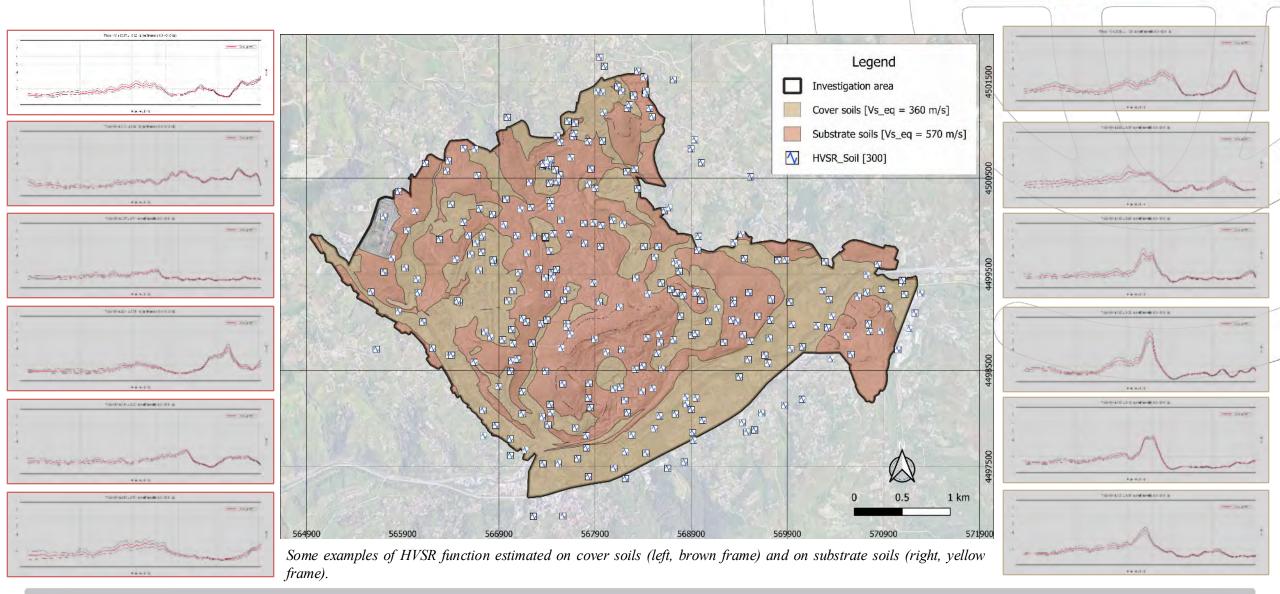


Example of overlap between the characteristic frequency of a foundation soil (in green) and the fundamental frequency of a building (in red); both vibrate at a frequency equal to 4.5 Hz.



#### HVSR\_Soil

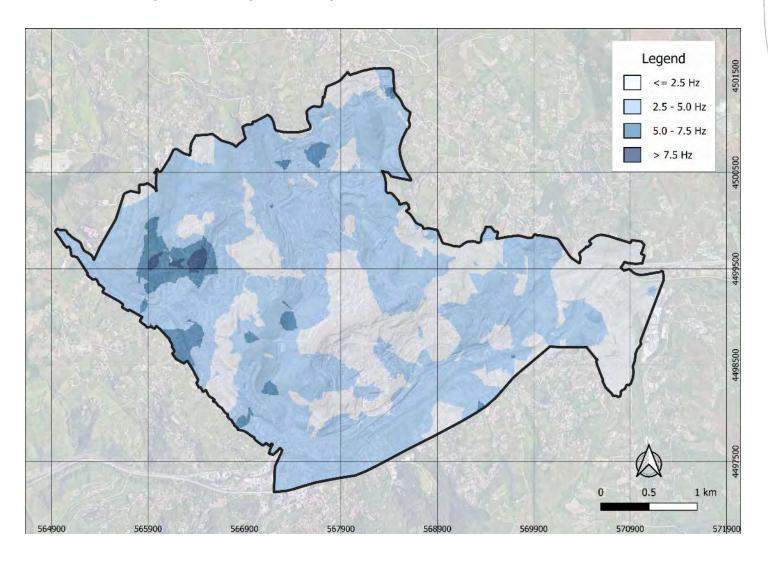


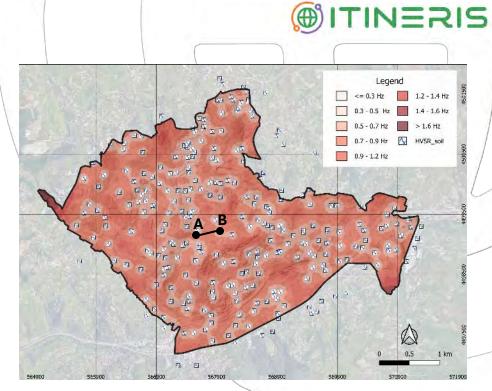


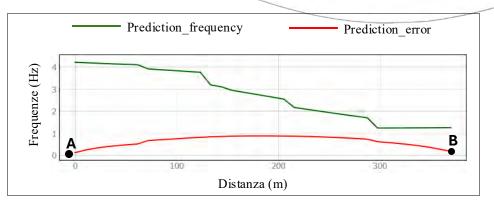
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3

#### Isofrequency map and related error



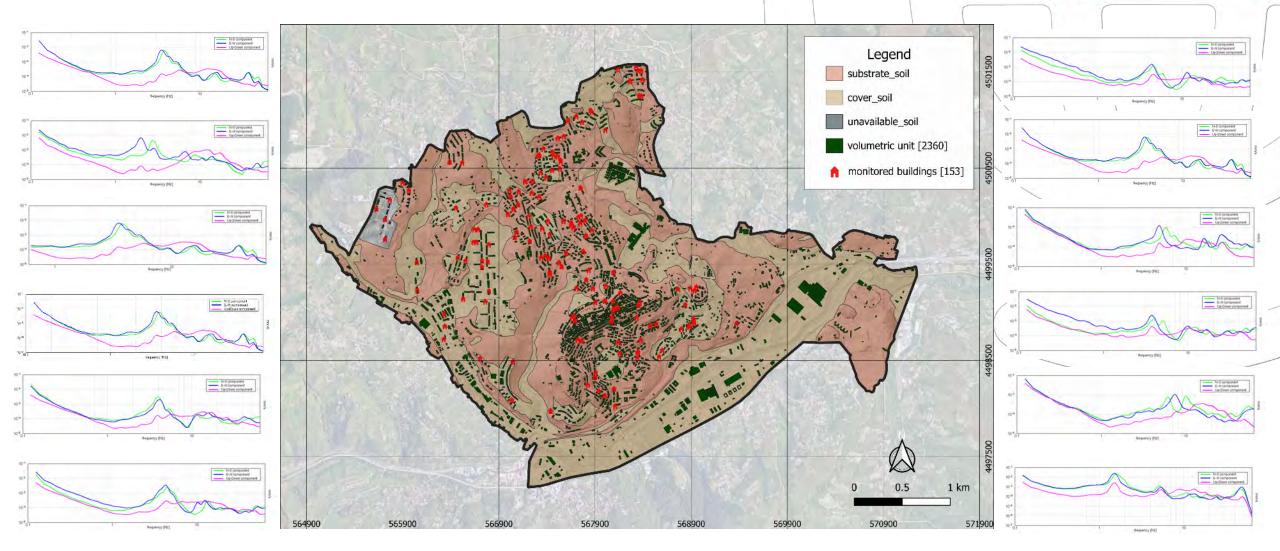




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### HVSR\_Building



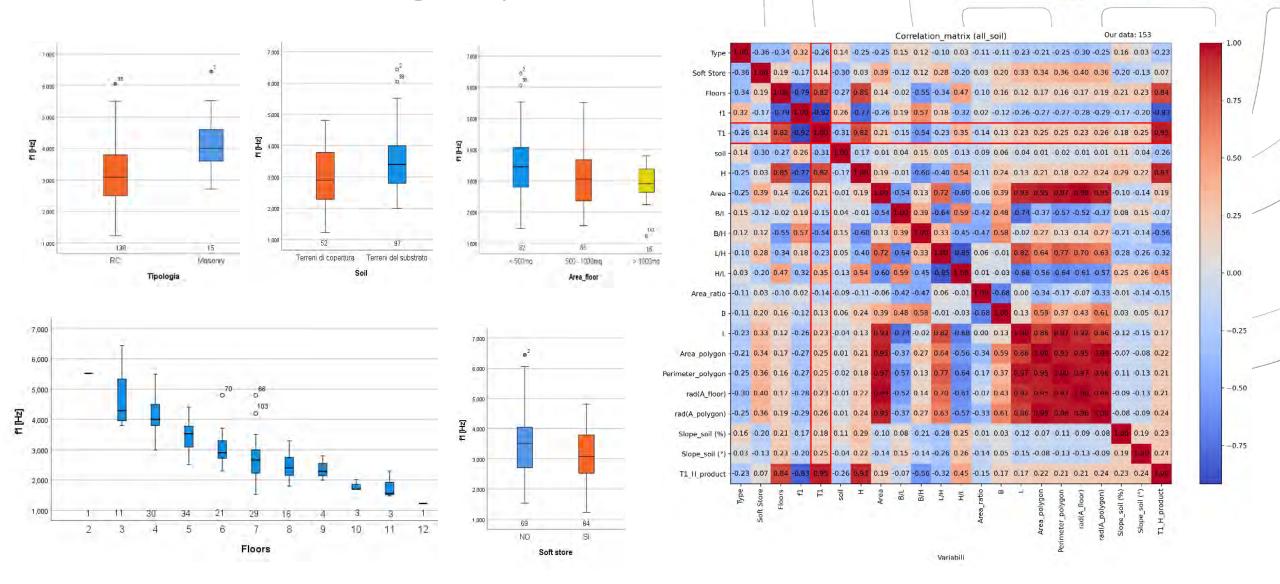


Some examples of HVSR function obtained on the different types of buildings present within the urban area of the city of Potenza.

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#### First results of building frequencies and correlation matrix **@ITINERIS**

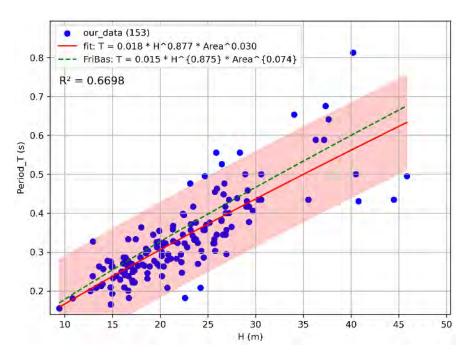




## Experimental relation and frequency of all buildings

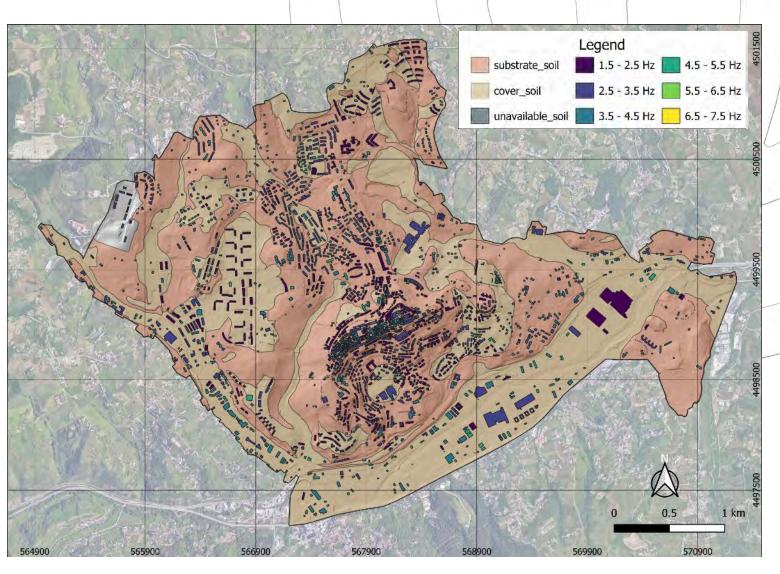


$$T = 0.018 * H^{0.877} * A^{0.074}$$



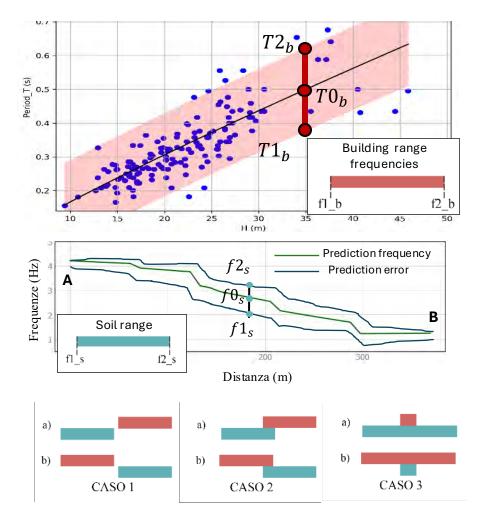
Up: Experimental relation (in red) with a power law that allows us to know the value of the Period (T) starting from the Height (H) and Area (A) values; in green relation obtained from the FriBas project.

To the right: The estimated HVSR first frequency of vibration for the 2360 buildings.

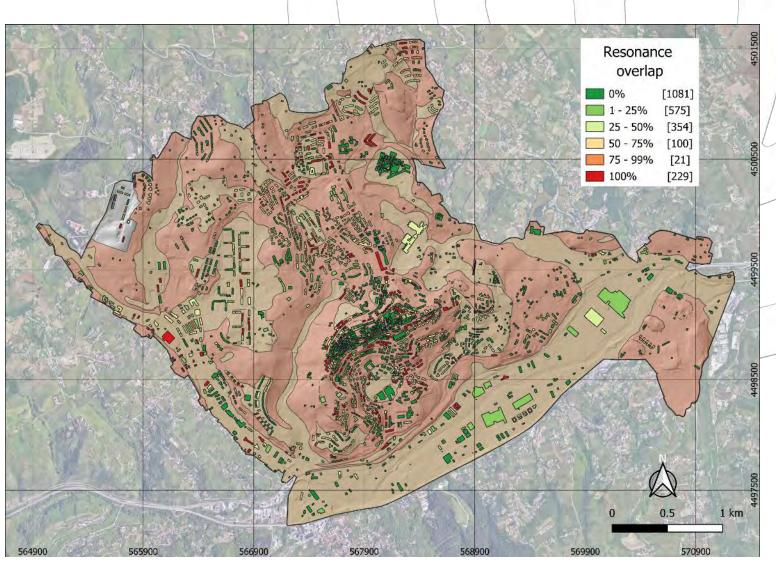


## Map of Soil-Building Resonance





Methods and Cases of intersection between the building range frequencies (in red) with the soil ones (in blue).





# THANKS!

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Matteo Feltracco<sup>1</sup>, Elena Barbaro<sup>2,1</sup>, Daniele Zannoni<sup>1</sup>, Mara Bortolini<sup>1</sup>, Eleonora Favaro<sup>1</sup>, Beatrice Ulgelmo<sup>2,1</sup>, Giovanna Mazzi<sup>1</sup>, Carlo Barbante<sup>1,2</sup>, Andrea Gambaro<sup>1,2</sup>, Marco Roman<sup>1</sup>

<sup>1</sup>Department of Environmental Sciences, Informatics and Statistics (DAIS), Ca' Foscari University of Venice

<sup>2</sup> Institute of Polar Science, National Research Council of Italy (CNR-ISP)









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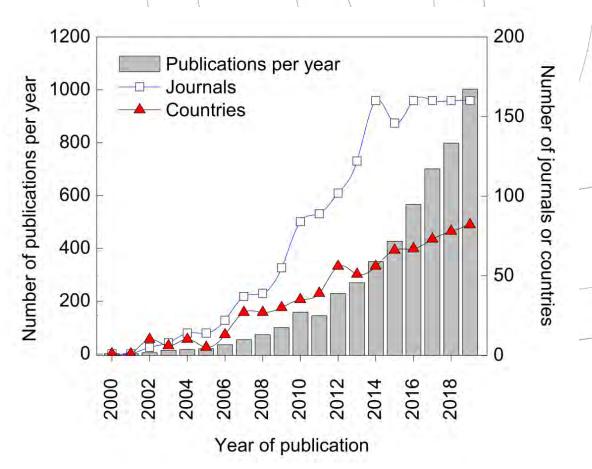






What is a contaminant?

The term «Contaminants of emerging Concern» (CECs) is used to describe substances that have been detected in the environment and may cause alterations or adverse impacts on ecosystems but are unregulated or inadequately regulated because they have become a concern only recently.



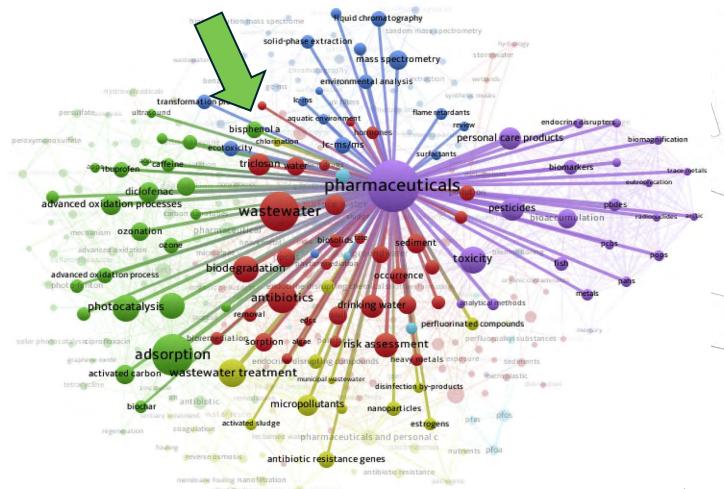








VOSviewer bibliometric map of most frequently mentioned keywords on global output on CECs from 2000 to 2019



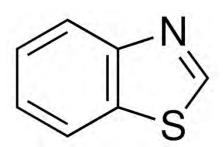








- © Europe has a monitoring program for emerging substances, named Watch List: Commission Implementing Decision (EU) 2022/1307, July 2022
- An example of unregulated chemicals are the benzothiazoles. They have been classified as high production volume chemicals and are contaminants of emerging concern.



Benzothiazole reached in 2015 an annual national aggregate production volume in the US of 720 tons (it was reported to be in the range of 4.5 - 450 tons in 1993

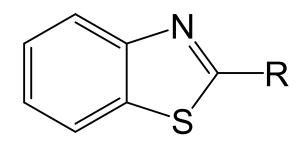
Name of substance/group of substances	CAS number (1)	EU number (²)	Indicative analytical method (*)· (*)	Maximum acceptable method detection or quantification limit (ng/l)
Sulfamethoxazole (5)	723-46-6	211-963-3	SPE-LC-MS-MS	100 (11)
Trimethoprim (5)	738-70-5	212-006-2	SPE-LC-MS-MS	100 (11)
Venlafaxine and O-desmethylvenlafaxine (°)	93413-69-5 93413-62-8	618-944-2 700-516-2	SPE-LC-MS-MS	6 (11)
Azole compounds ( <sup>7</sup> )			SPE-LC-MS-MS	
Clotrimazole	23593-75-1	245-764-8	711111	20 (11)
Fluconazole	86386-73-4	627-806-0		250 (11)
Imazalil	35554-44-0	252-615-0		800 (11)
Ipconazole	125225-28-7	603-038-1		44 (11)
Metconazole	125116-23-6	603-031-3		29 (11)
Miconazole	22916-47-8	245-324-5		200 (11)
Penconazole	66246-88-6	266-275-6		1 700 (11)
Prochloraz	67747-09-5	266-994-5	4	161 (11)
Tebuconazole	107534-96-3	403-640-2		240 (11)
Tetraconazole	112281-77-3	407-760-6		1 900 (11)
Dimoxystrobin Azoxystrobin (*)	149961-52-4 131860-33-8	604-712-8 603-524-3	SPE-LC-MS-MS	32 (11) 200 (12)











Benzothiazoles are employed in various industrial processes.



**Rubber vulcanization** 

1) —H

Half-life in water: 15 days

- 3)  $-CH_3$
- 4) —S —S
- = s
- 6) -s'
- **7)** —OH Half-life in wa
- 8) —S\_OH



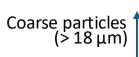








#### What happen in the urban aerosol?



Ultra fine particles (< 56 nm)



12 stages impactor

#### Mestre-Venice

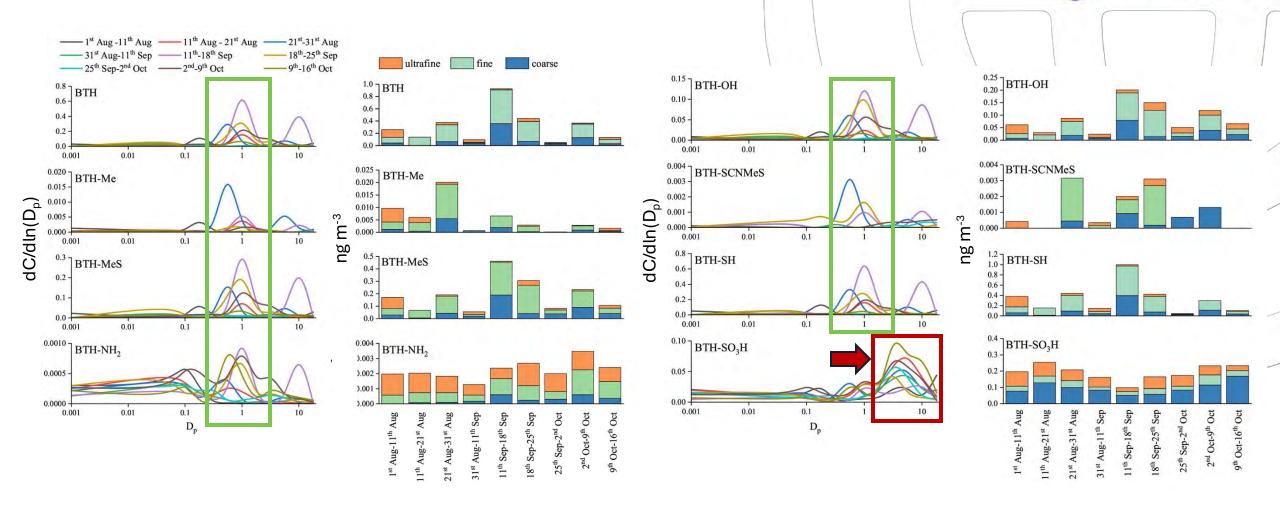












The predominant compounds are **BTH-SH** and **BTH** (30% and 28%, 0.3  $\pm$  0.3 ng m<sup>-3</sup>), followed by **BTH-SO<sub>3</sub>H** and **BTH-MeS** (17% and 17%, 0.19  $\pm$  0.05 and 0.19  $\pm$  0.13 ng m<sup>-3</sup>)





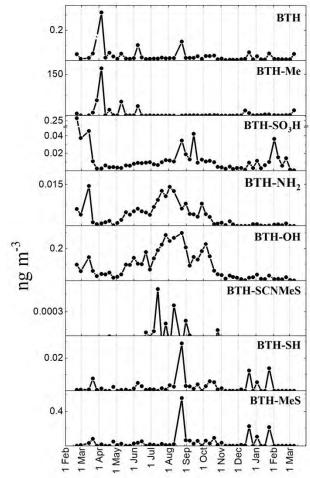


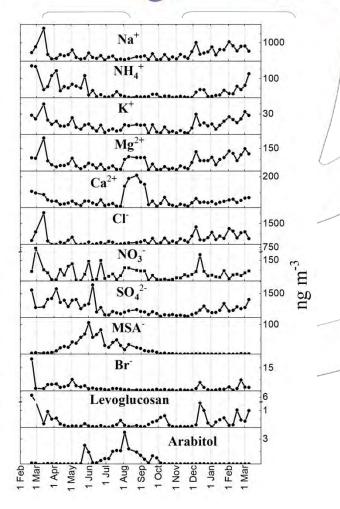


#### From Venice to the Arctic

High volume PM10 sampler, a year-round sampling (Feb 2022 – Feb 2023) at Ny-Ålesund, Svalbard.







The most abundant is **BTH-OH** (58% with a concentration range between 0.001 and 0.3 ng m<sup>-3</sup>). **BTH, BTH-MeS**, and **BTH-SO<sub>3</sub>H** represent 17%, 11%, and 10%

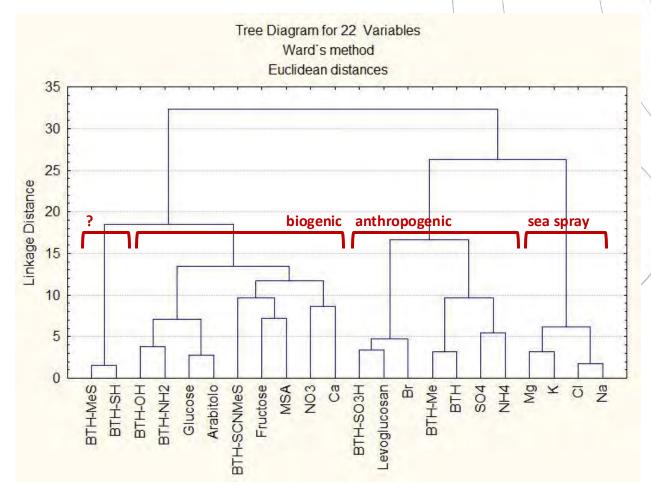








#### Why they are there?











#### There's more to come!

We're planning new sampling aerosol campaigns in the new station of Col Margherita (MRG) with more samplers and more contaminants that need to be found

- Sequential high flow PM10 sampler for 12-hour resolution sampling
- Sequential low flow PM10 and PM1 sampler for long term sampling (96 h resolution)
- High flow impactor sampler (10, 2.5, 1.4, 0.77, 0.44 and 0.25 μm) for spot-campaign







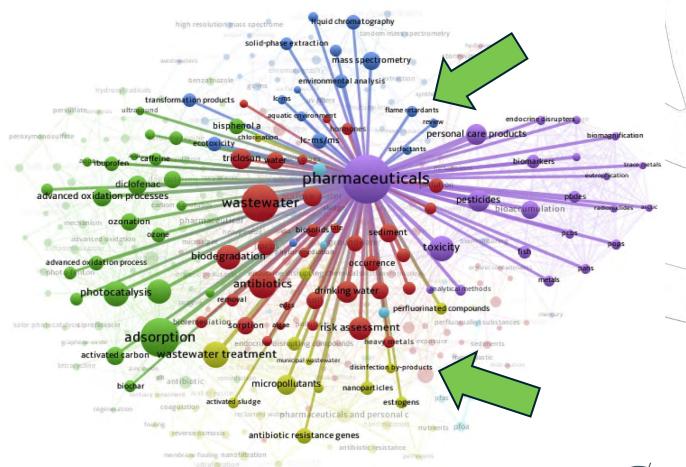






There's more to come!

New substances: haloacetic acids, benzotriazoles, drugs, new flame retardants (organophosphate)











# THANKS!



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# Potentiality of Remote Sensing Instruments for Retrieval of Aerosol Vertical Profiles: Monitoring, Alerting, and Characterization

Alessandro Bracci<sup>1</sup>, Annachiara Bellini<sup>2</sup>, Ferdinando Pasqualini<sup>1</sup>, Camilla Perfetti<sup>1</sup>, Luca Di Liberto<sup>1</sup>, Angela Marinoni<sup>1</sup> and Francesca Barnaba<sup>1</sup>

<sup>1</sup>Consiglio Nazionale delle Ricerche, Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC)

<sup>2</sup>ARPA Valle d'Aosta

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"











- Aerosols exert a significant influence on weather and climate dynamics, impacting critical sectors of human society.
- Aerosols also play a crucial role in air quality. Air Quality Monitoring Networks (AQMN) within the EU primarily utilize in situ instrumentation to collect data and monitor PM levels.

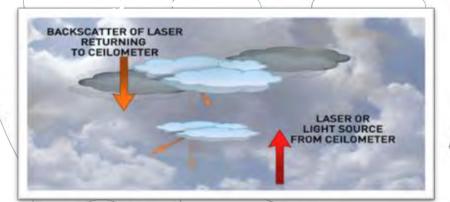
## **Background**

- However, many AQMN currently lack vertically resolved data, which is essential for a comprehensive understanding of aerosol concentration dynamics at different atmospheric levels.
- Wertically resolved data enhances the assessment of atmospheric dispersion patterns both vertically and horizontally. It also facilitates the identification of potential nonlocal sources of pollution, including those transported over medium to long distances.

## What's an Automated Lidar-Ceilometers (ALCs)?



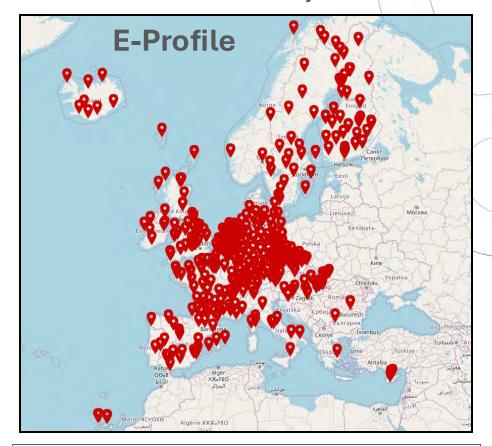
- ALCs are remote sensing instruments based on lidar technique.
- ALC is capable of providing a finely resolved vertical structure of atmospheric particulate matter continuously and unattended.
- ALCs are valued for their robustness and cost-effectiveness, being more affordable than traditional lidars and simpler to operate and maintain.
- ALC laser emits a single wavelength, and the acquisition system records the radiation scattered back by aerosol and molecules:
  - Rayleigh scattering  $\rightarrow \lambda^{-4} \rightarrow$  molecules
  - Mie scattering  $\rightarrow \lambda^{-1} \rightarrow$  small particles
  - Geo. optics  $\rightarrow \lambda \rightarrow$  large particles
- ® Recently, ALCs have introduced depolarization measurement capabilities, allowing for the discrimination of particle shapes.
- Traditionally used in aviation to detect cloud base heights (cloud ceiling), ceilometers are now increasingly utilized for vertical atmospheric profiling with various applications.







The adoption of ALC systems is expanding across national and international networks. In Europe, most Member States operate extensive ALC networks and actively contribute to the EUMETNET E-Profile initiative.



> 450 ALCs from 26 countries, mostly run and managed by National Meteo Services



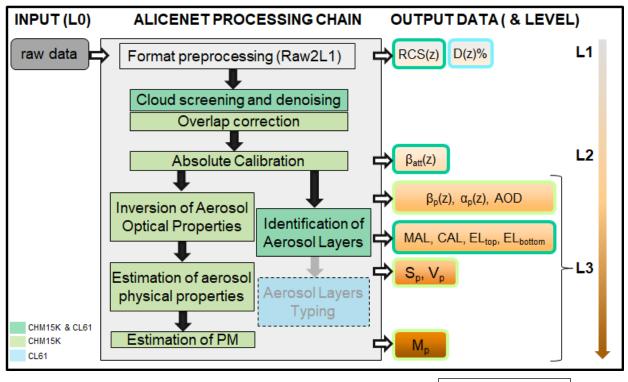
Alicenet is a growing consortium network established and coordinated by CNR-ISAC and involving different partner institutions including EPAs in Italy. Several systems run in large urban areas (Milan, Turin, Genoa, Florence, Rome) and in middle size cities (Aosta, Potenza, Lamezia Terme, Catania). Coastal, mountain and volcanic environments are also monitored.







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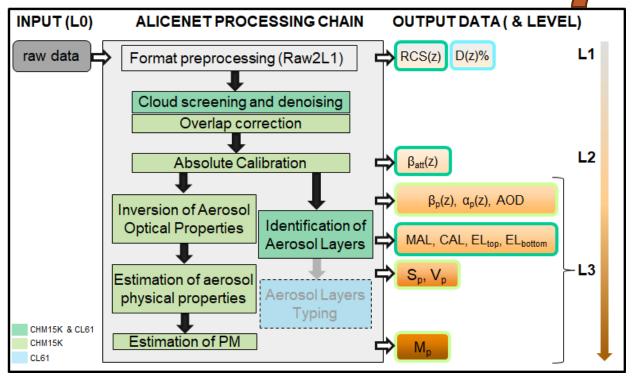


Bellini et al., 2024



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Bellini et al., 2024

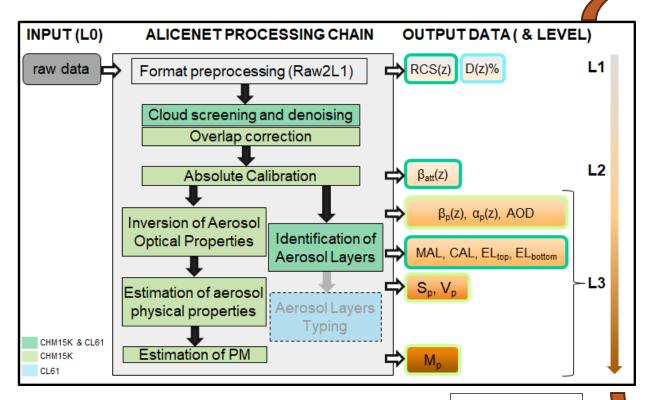
#### **Basic Products**

Attenuated backscatter Depolarization ratio



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and volcanic environments are also monitored.



#### **Basic Products**

Attenuated backscatter Depolarization ratio

#### **Advanced Products**

Aerosol Optical Properties
(Backscatter, Extinction/AOD)
Aerosol Mass
Aerosol Stratification (including ABL/MAL)
Aerosol Typing

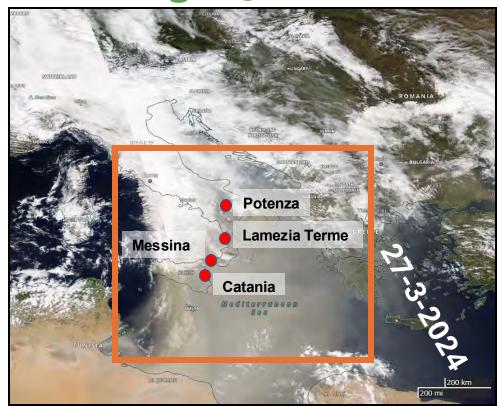
Bellini et al., 2024

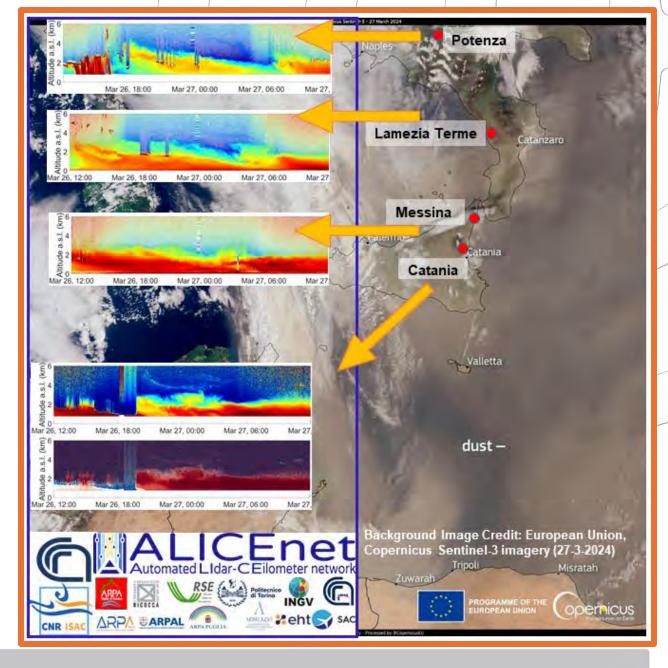
## Monitoring - e.g. Dust Advections





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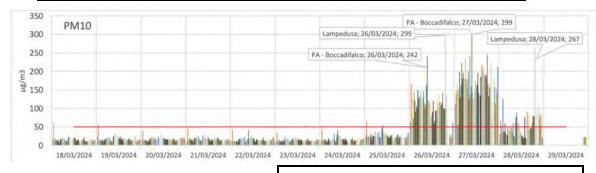




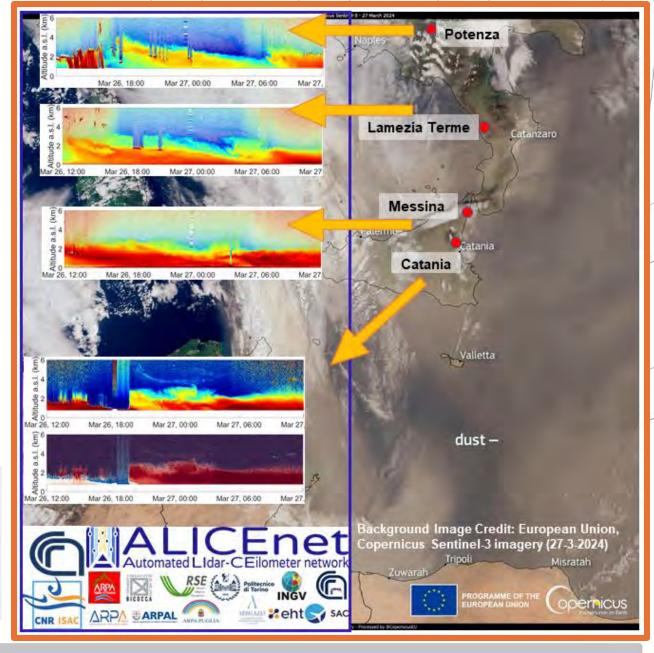
Annual meeting – Rome – 9-10/07/2024 10

## Monitoring - e.g. Dust Advections

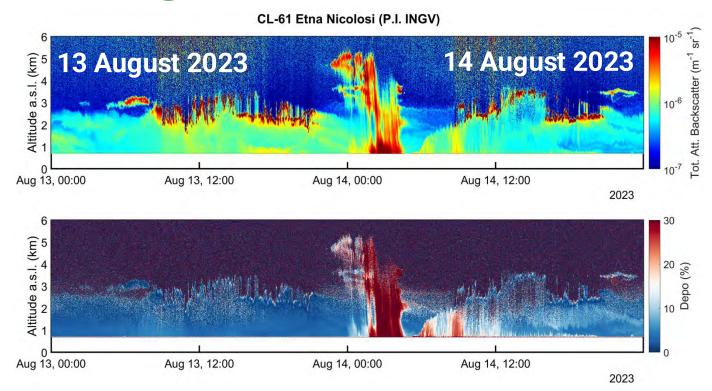




Daily Average  $PM_{10} > 100 \mu g/m^3$ 

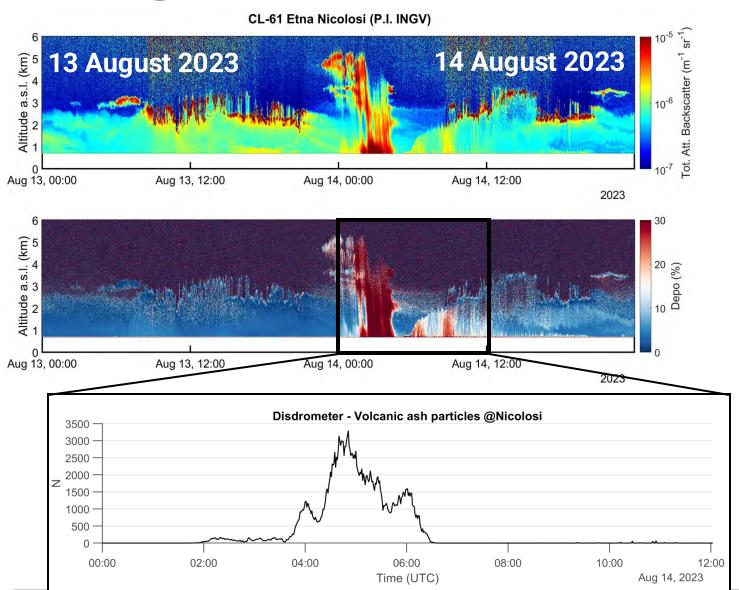


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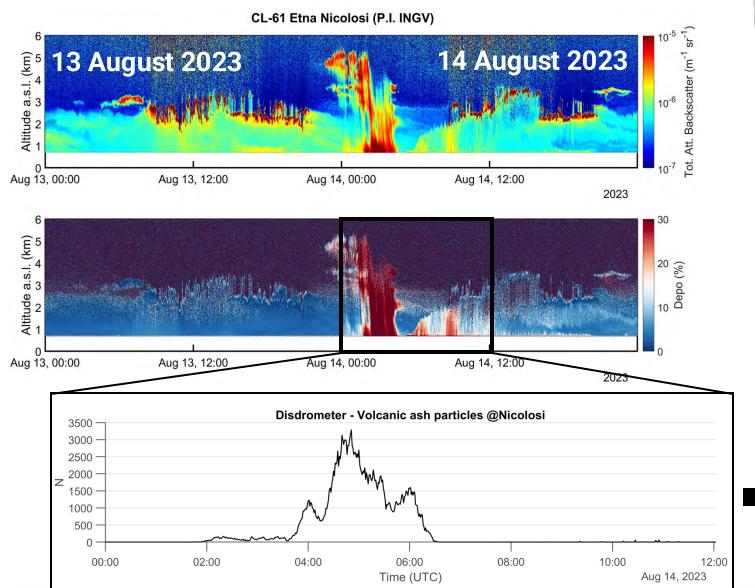


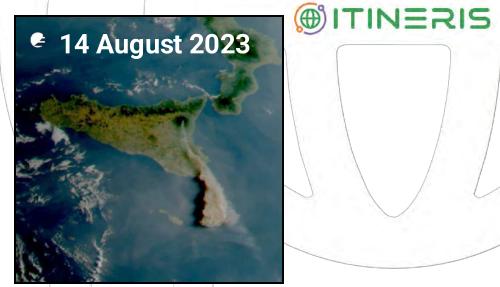
Annual meeting – Rome – 9-10/07/2024

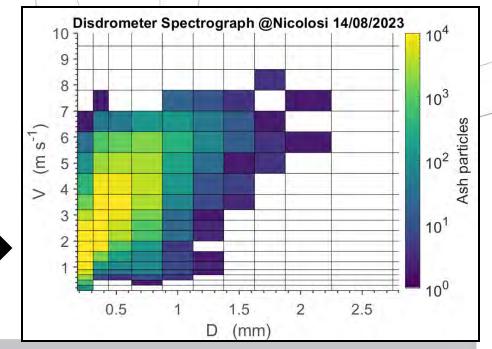




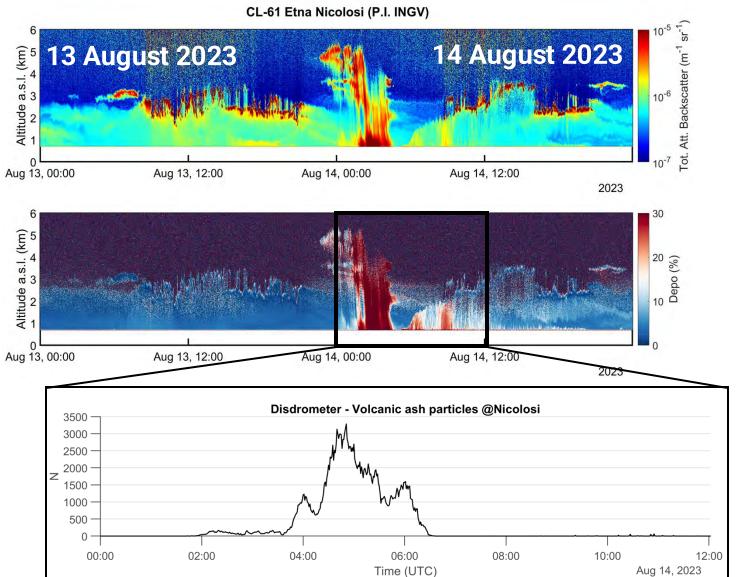
Courtesy of Coltelli and Giammello (INGV-Catania)



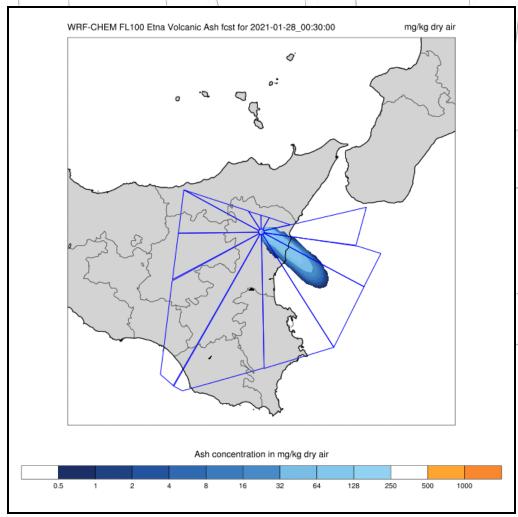




Annual meeting — Rome — 9-10/07/2024







Courtesy of Franco Colombo (AM)

## **Characterization** – e.g. Climatology

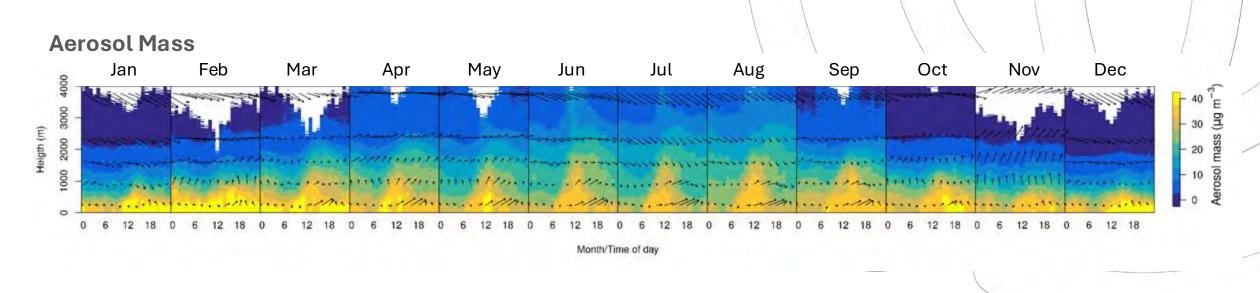
Rome 2016-2022



Annual meeting – Rome – 9-10/07/2024

## **Characterization** – e.g. Climatology

Rome 2016-2022



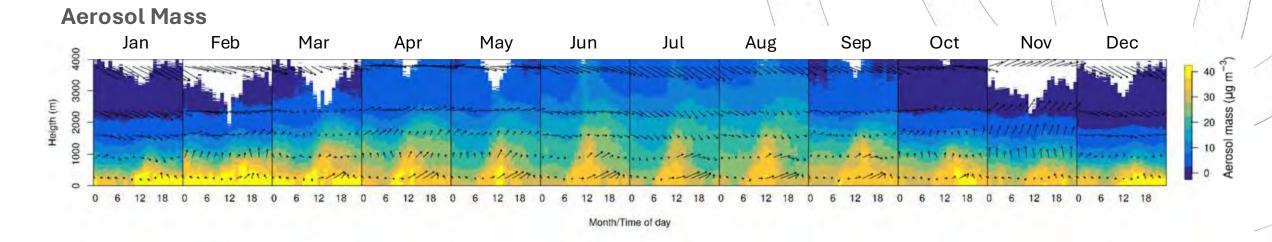
Annual meeting – Rome – 9-10/07/2024

ITINERIS

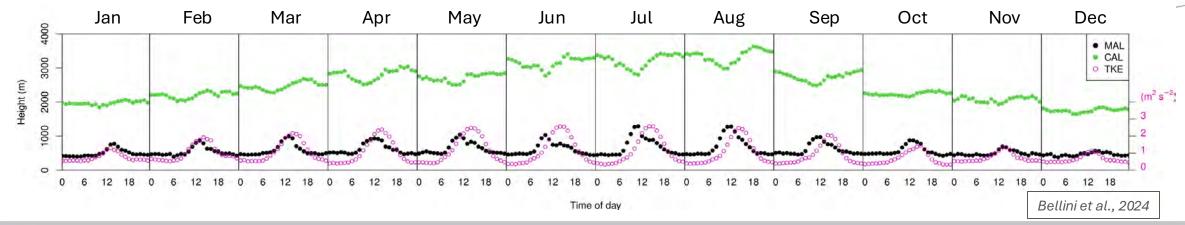
## Characterization - e.g. Climatology

Rome 2016-2022









Annual meeting — Rome — 9-10/07/2024

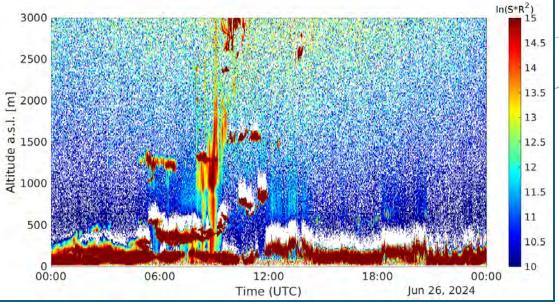
## **ALC in ITINERIS**

In the framework of the PRIN 2022-GAIA project, CNR-ISAC has developed GaInfra, a mobile laboratory for aerosol characterization. This suite of instruments includes the **ITINERIS ALC** for vertical profiling.

GaInfra is currently operational in the Arctic Ocean aboard the Polarstern icebreaker, managed by the AWI.







Annual meeting – Rome – 9-10/07/2024

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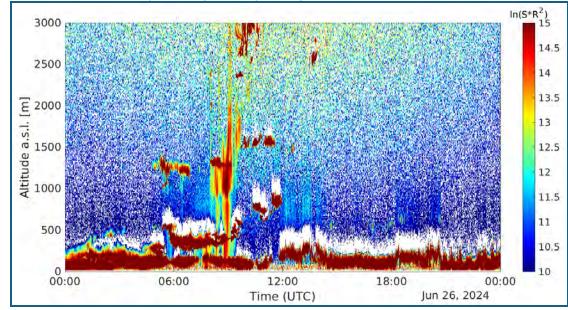
#### **Basic Products**

Attenuated backscatter

#### **Advanced Products**

Aerosol Optical Properties
(Backscatter, Extinction/AOD)
Aerosol Mass
Aerosol Stratification (including ABL/MAL)
Aerosol Typing





Annual meeting - Rome - 9-10/07/2024



## THANKS!



a.bracci@isac.cnr.it

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"











## DiSSCo: Enhancing Open Science with effortless knowledge exchange - Data modelling -

Eleonora Fornaro\*, Massimo Ianigro\*\*, Domenico De Paola\*, Marina Tumolo\*, Gabriele Bucci\*\*\*
ITINERIS OU CNR-IBBR-BA (Activity 6.5) \* CNR-IBBR, Bari; \*\* CNR-IRSA, Bari; \*\*\* CNR-IBBR, Firenze





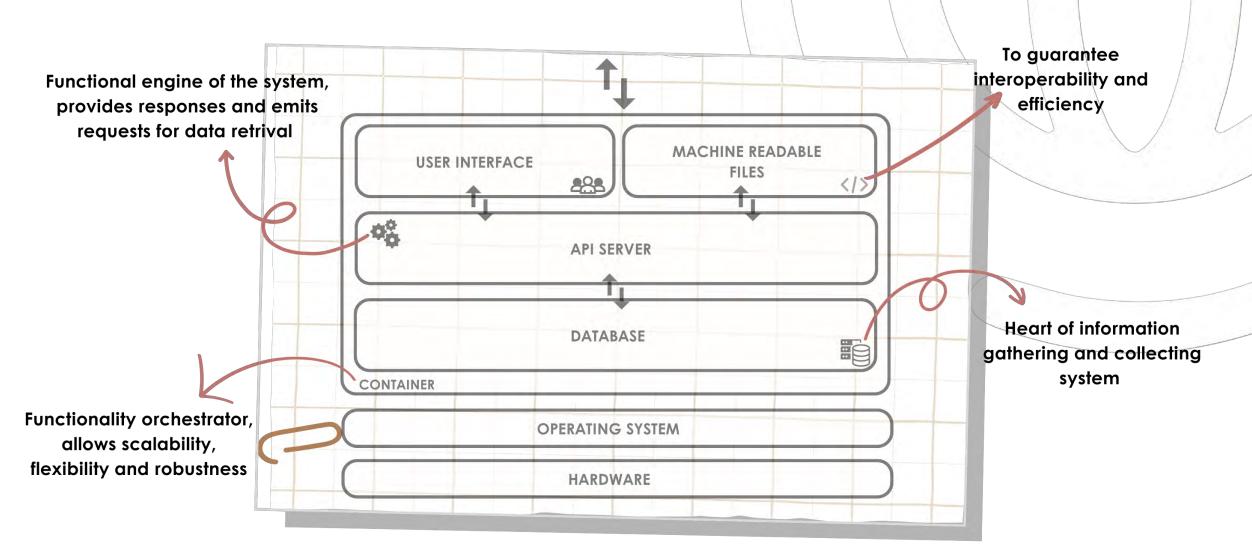




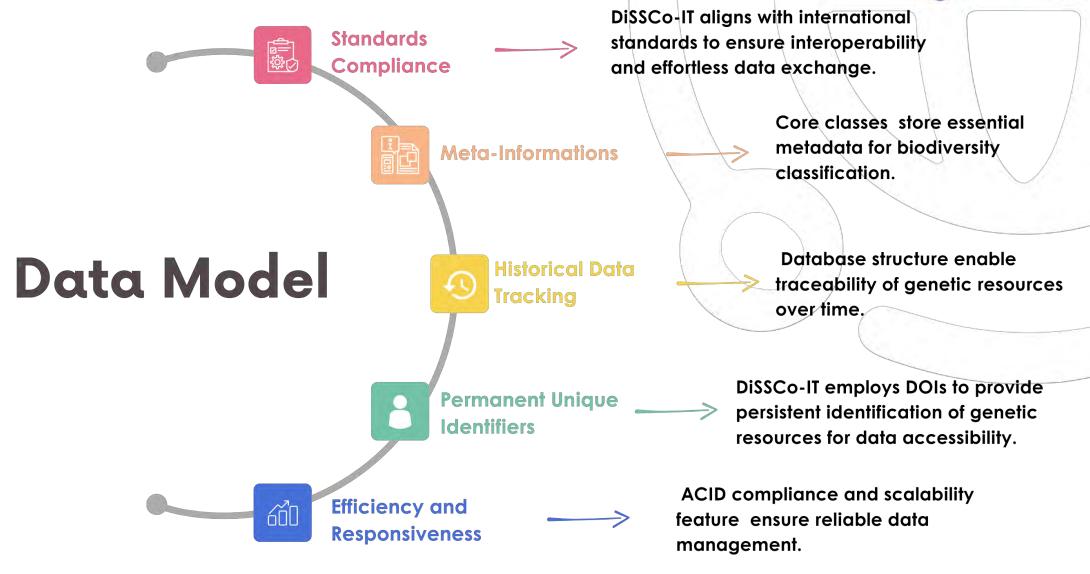


## HOW?



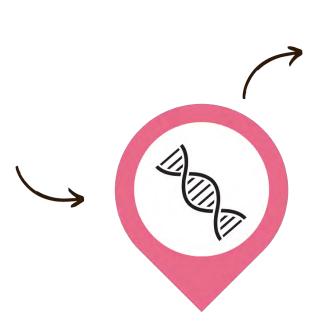






## FUTURE APPLICATIONS





Essential Biodiversity Variables

Assessing biodiversity at different scales



Species Distribution Modeling

Geographic distribution under future climate scenarios



Mapping Endangered Species

Geographic analysis of regions at risk of erosion/depletion



Data Resource Utilization

Taxonomic Data Genetic Data Ecological Data



Functional Biodiversity

Adaptation to climate change Mitigation strategies



## THANKS!













# Variability of Volatile Organic Compounds in the Urban Atmosphere of Milan

Nora Zannoni









## The Urban Atmosphere

- Premature deaths attributable to  $PM_{2.5}$  in the EU were 253,000 (2021), fell by 41% in 20 years
- 70% EU population live in urban areas
- 97% of the urban population was still exposed to PM<sub>2.5</sub> concentrations above the new (2021) WHO air quality guideline level of 5μg/m<sup>3</sup>.
- Po Valley: 50,303 deaths in 2020 due to air pollution
- Urgent need to have enhanced AQ policy assessment and evaluation of health effects in Europe: ITINERIS/ ACTRIS/ RIURBANS
- Focus on urban tracers & influence of the boundary layer height

'Impossible to live like this': Italy's Po Valley blighted by air pollution among worst in Europe

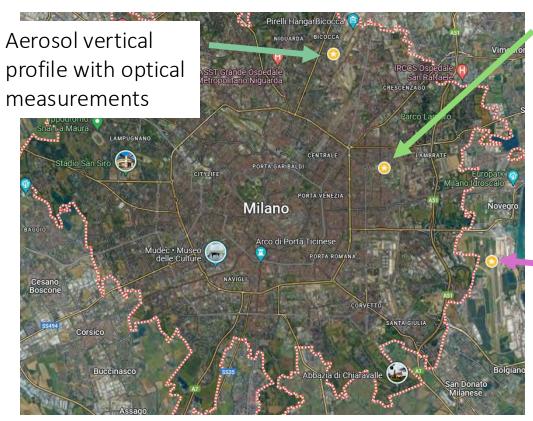


Source: The Guardian UK, Sept 2023





## One-year-long campaign in urban Po Valley ITINERIS



#### 3. URBAN AREA SPATIAL DISTRIBUTION



#### 1. URBAN BACKGROUND REF SITE



VOCs, GHGs, NOx, eBC, aerosol chemical speciation

#### 2. POLLUTION HOT-SPOT SITE



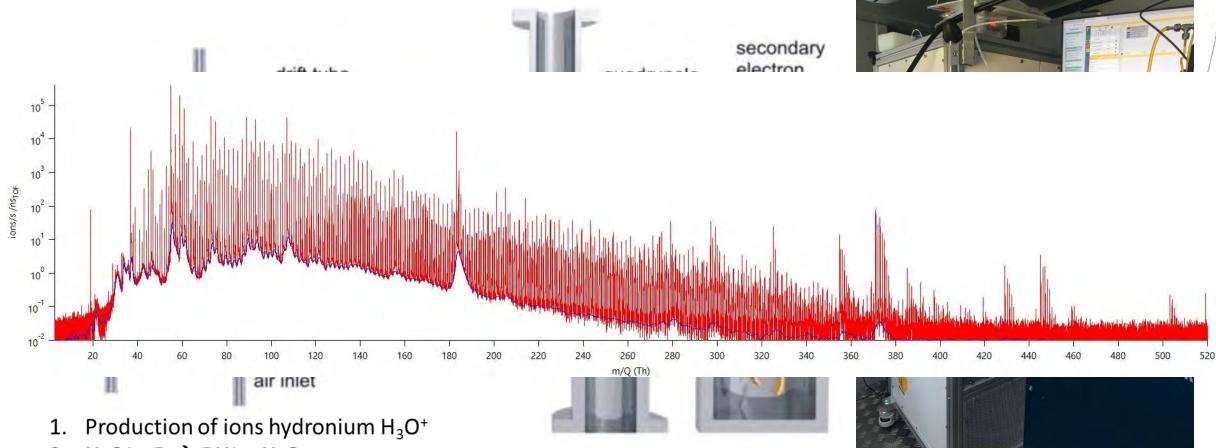
SD 10-800 nm, N tot, SD 300nm-20µm SD 500nm-20µm, eBC, Scattering, NOx, Meteo, Pyranometer

+ 4. SUBURBAN SITE BOLOGNA

O<sub>3</sub>, NOx, eBC, aerosol chemical speciation

## Proton Transfer Reaction Mass Spectrometry

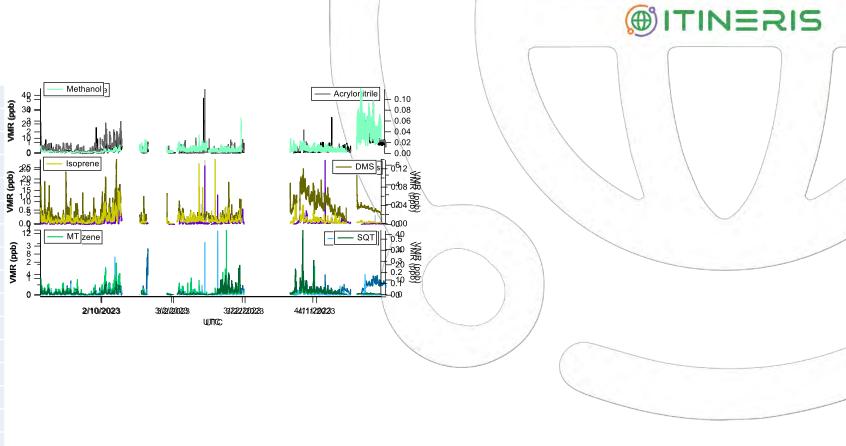




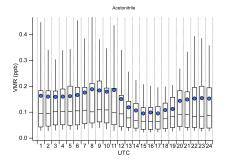
- 2.  $H_3O^+ + R \rightarrow RH^+ + H_2O$
- 3. Compounds are differentiated according to their m/z
- 4. The ion signal is converted into electrical signal

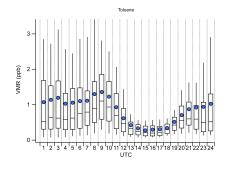
## Targeted VOCs

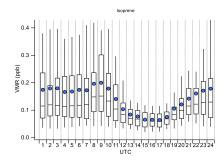
ion	x0	Detection limit
CH5O+	33.033491	DL=984 ppt
C2H4N+	42.033826	DL=13 ppt
C2H5O+	45.033491	DL=124 ppt
C2H7O+	47.049141	DL=179 ppt
C3H4N+	54.033826	DL=2 ppt
C3H7O+	59.049141	DL=91 ppt
C2H7S+	63.026298	DL=1 ppt
C5H9+	69.069877	DL=7 ppt
C4H7O+	71.049141	DL=19 ppt
C4H9O+	73.064791	DL=11 ppt
C6H7+	79.054227	DL=104 ppt
C7H9+	93.069877	DL=4 ppt
C8H11+	107.085527	DL=2 ppt
C9H13+	121.101177	DL=1 ppt
C10H17+	137.132477	DL=1 ppt
C5Cl3H16+	181.03121	DL=1.67 ppb
C15H25+	205.195077	DL=4 ppt
C8H25O4Si4+	297.082442	DL=0 ppt
C10H31O5Si5+	371.101233	DL=1 ppt

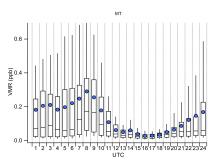


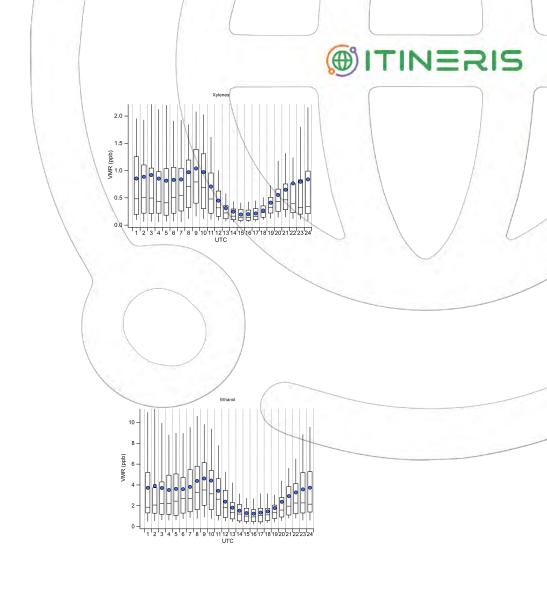
## Diel variability



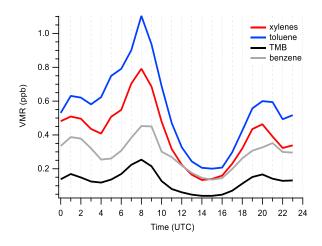


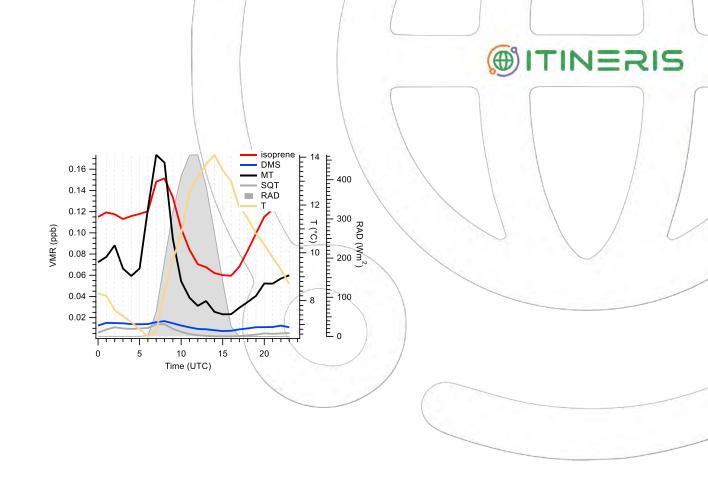






## Sources of emissions



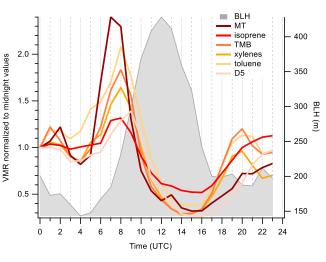


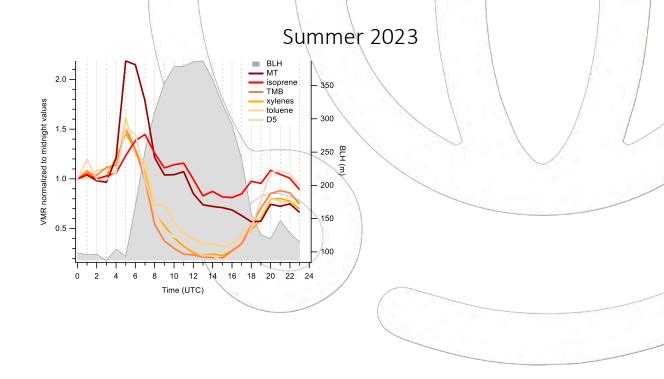
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## Atmospheric dispersion vs. other processes







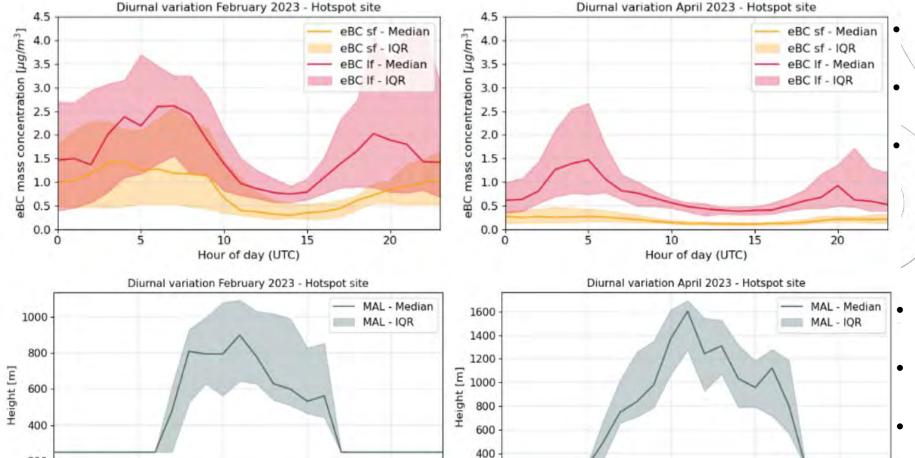


BLH data source: Marta Salvati (ARPA Lombardia)

Method: sonic anemometer

## Atmospheric dispersion with a primarily-emitted nonreactive tracer





200

5

- eBC measured at the hot-spot site
- Same diel variability as reactive VOCs
- Source apportionment reveals a dominant contribution from traffic (liquid fuel)

- Mixed Aerosol Layer proxy for boundary layer height
- Back scattering measured with a Ceilometer
- Retrieval algorithm to obtain MAL (Bellini et al,2024)

Source: Camilla Perfetti

20

15

Hour of day (UTC)

15

10

Hour of day (UTC)

20

200

## Conclusions



- First real-time VOC measurements at a urban site Po valley area
- Concentration diel variability: explained by emission sources (morning and evening) & atmospheric dispersion (daytime)
- Role of reactivity on VOC concentrations to be investigated

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## THANKS!













## Last achievements on aerosol typing at ChAMBRe



#### V. Vernocchi<sup>1</sup>

E. Abd El<sup>1, 2</sup>, M. Brunoldi<sup>1, 2</sup>, E. Gatta<sup>2</sup>, M. Irfan<sup>2</sup>, T. Isolabella<sup>1, 2</sup>, F. Mazzei<sup>1, 2</sup>, D. Massabò<sup>1, 2</sup>, F. Parodi<sup>1</sup>, P. Prati<sup>1, 2</sup>

<sup>1</sup>Istituto Nazionale di Fisica Nucleare, Sezione di Genova

<sup>2</sup>Università degli Studi di Genova, Dipartimento di Fisica









#### ChAMBRe: Chamber for Aerosol Modelling and Bio-aerosol Research



© Chamber is installed at the National Institute of Nuclear Physics in Genoa in collaboration with the Environmental Physics Laboratory at the Physics Department of Genoa University (www.labfisa.ge.infn.it). The facility is part of the ERIC-ACTRIS.

#### Facility with high versatility!

- Bioaerosol studies
- Carbonaceous aerosol studies
- Study of the optical properties of atmospheric aerosols
- Characterization of innovative instruments and techniques for the analysis of atmospheric aerosols and their properties
- and many others...



## ChAMBRe equipment

#### **AMBIENT PARAMETERS**

- **□** Sensors:
  - Pressure (inside & outside)
  - Temperature (inside & outside)
  - Relative humidity (controlled, range 0-98%)

#### **GASES**

#### **□** Analyzers:

- O<sub>3</sub>
- NO<sub>x</sub>, NO, NO<sub>2</sub>
- CO,CO<sub>2</sub>
- VOCs BTEX
- SO<sub>2</sub>

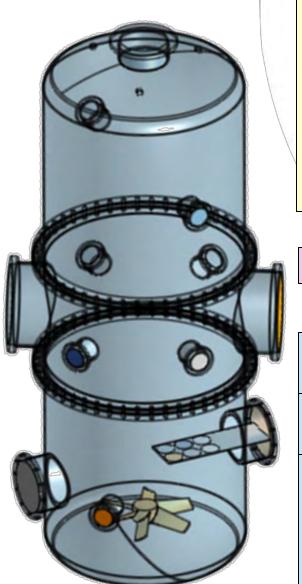
#### ☐ **Injection** system:

- O<sub>3</sub>
- NO, NO<sub>2</sub>
- CO, CO<sub>2</sub>
- SO<sub>2</sub>
- CH<sub>4</sub>
- ...

#### **AEROSOL GENERATORS**

#### **☐** Nebulizers:

- BLAM (Blaustein atomizer)
- Collison Nebulizer
- SLAG (Sparging Liquid Aerosol Generator)
- ☐ Mini Inverted Soot Generator
- ☐ Flow Focusing Monodisperse Aerosol Generator
- ☐ Diesel generator set
- ☐ Shaking dust generator



#### **AEROSOL MONITORS**

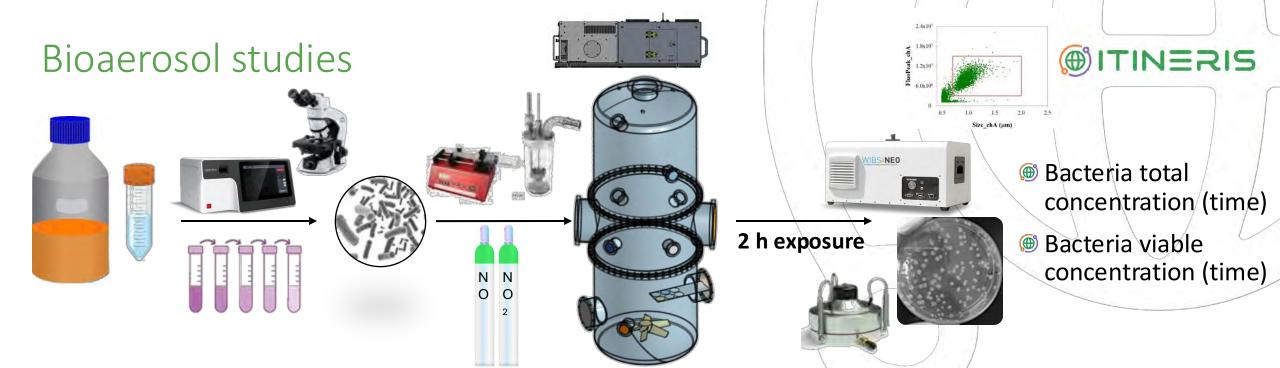
- ☐ Particle counters/sizers:
  - SMPS (Scanning Mobility Particle Sizer)
  - OPS (Optical Particle Sizer)
  - APS (Aerodynamic Particle Sizer)
- **□** Optical properties:
  - PAX (Photoacoustic extinctiometer, λ: 870, 532, 405 nm)
  - Nephelometer (Aurora 4000)
  - CASS (Carbonaceous Aerosol Speciation System)
- ACSM (Aerosol Chemical Speciation Monitor)

#### **BIOAEROSOL**

☐ WIBS (Waveband Integrated Bioaerosol Sensor)

#### **OTHER**

- ☐ Sterilizer UV-lamp
- **□** Solar Simulator
- ☐ Mixing Fan
- **☐ Vacuum pumps** system ( $P_{min} \approx 10^{-5}$  mbar)
- **☐** External samplers
  - Andersen impactor
  - Liquid impinger
  - Sequential/single sampler
  - Automated tray for passive samplers

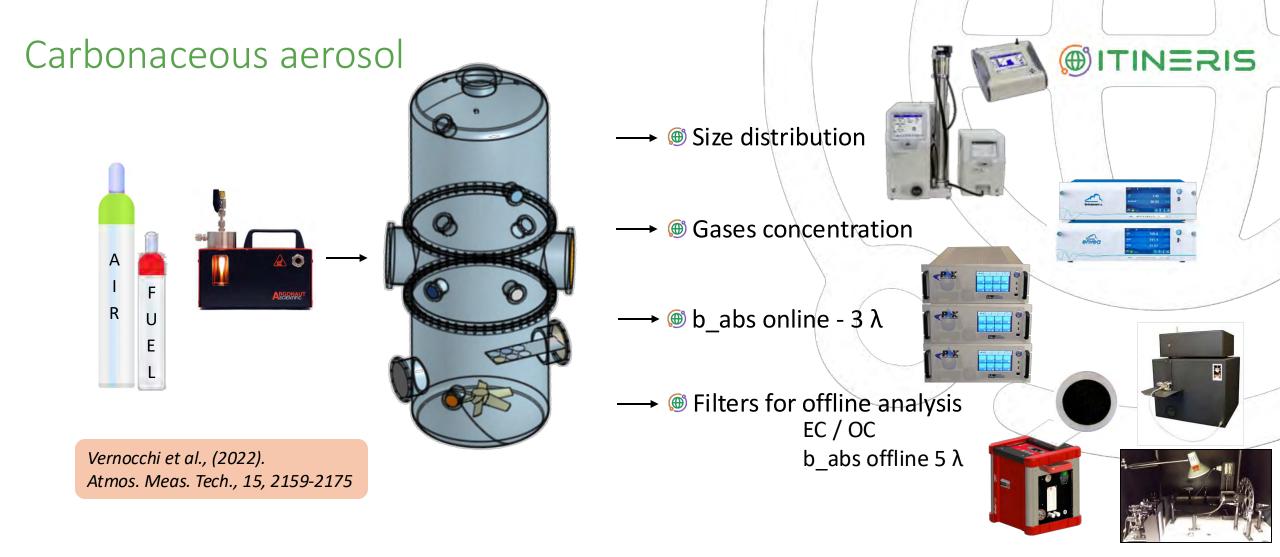


- Impact of air quality on bacteria viability: effects of different atmospheric conditions and/or anthropogenic pollutants
  - @ Systematic studies using three standard-model bacteria but different strains can be used
  - Investigation of NO / NO<sub>2</sub> and Solar radiation effects
  - Experimental protocol applicable to other atmospheric pollutants (not only gases)

Vernocchi et al., (2023). Atmos. Meas. Tech., 16, 5479-5493



**POSTER:** Studies at ChAMBRe on the viability of bacterial strains versus  $NO_x$  concentration (Vernocchi et al.) – Session 3, Poster 36, Monitor 11



- Test of different **fuels** and different **combustion conditions**
- Well-characterized soot particles with known properties to be used in different applications

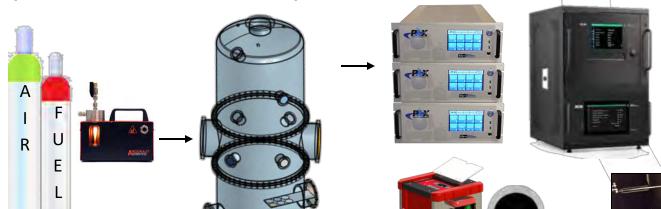
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### Characterization of new instrument TINERIS Pure soot Different filter loadings Absorbance **B**roadband Light **An**alyzer of Complex Aerosol Isolabella et al., (2023) 750 Il Nuovo Cimento C, 46 λ (nm)

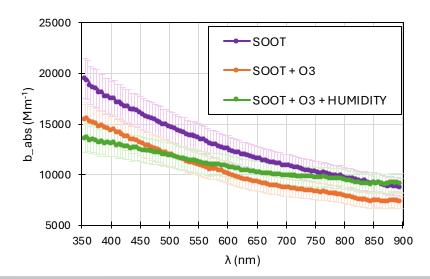
BLAnCA POSTER: BLAnCA: a new broadband light absorption spectrometer for complex aerosol developed at ChAMBRe (Massabò et al.) - Session 3, Poster 37, Monitor 12

## Optical properties of atmospheric aerosols

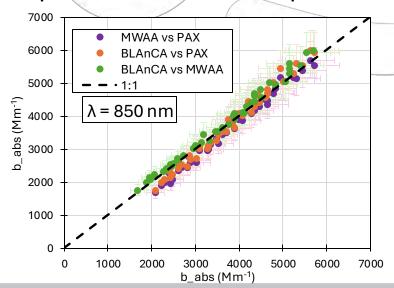




#### Comparison of different aerosols



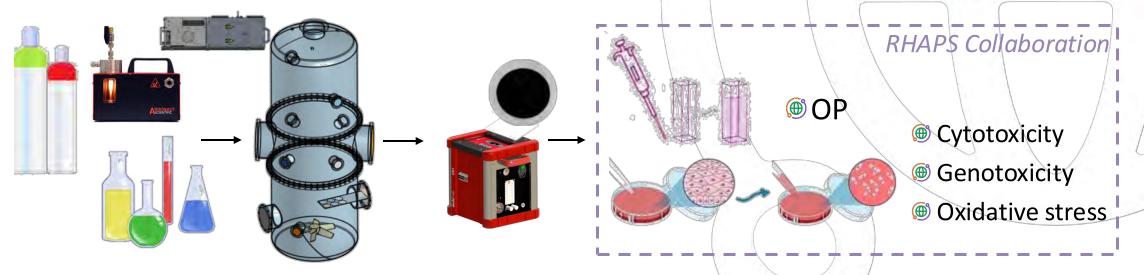
#### © Comparison of different optical techniques



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## Standard samples for OP and Toxicological assays





#### WINTER – BB emissions

- 1) BC, dark condition
- 2) BC + NO<sub>2</sub> + O<sub>3</sub>, Dark
- 3) BC +  $NO_2$  +  $O_3$  + ammonium nitrate, *Dark*
- 4) BC +  $NO_2$  +  $O_3$  + 2,5-dimethylfuran, *Dark*
- 5) BC +  $NO_2$  +  $O_3$  + ammonium nitrate + 2,5-dimethylfuran, *Dark*

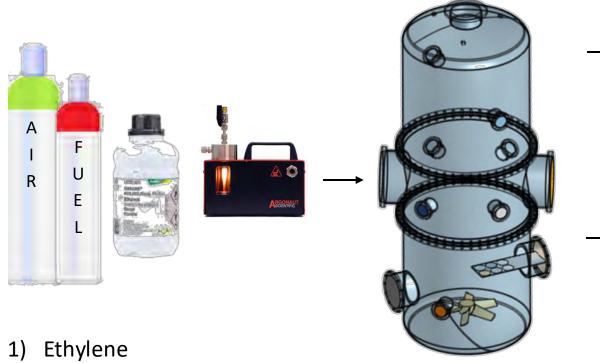
#### SUMMER – TRAFFIC emissions

- 1) BC + solar radiation (light condition)
- 2) BC + HONO, Light
- 3) BC + HONO + ammonium sulphate, *Light*
- 4) BC + HONO + toluene, *Light*

Results In progress

## Standard samples for Toxicological assays





Particles characterization by ChAMBRe instruments



- Ethylene + 5% Ethanol
- Ethylene + 10% Ethanol
- Ethylene + 20% Ethanol
- SAF (Sustainable Aviation Fuel)

- ULTRAFINE particles
- Simulate biofuels blends emissions



### Projects & Grants



The development of the chamber and the deployment of the equipment was supported by several European and Italian projects/grants:

- PRIN2017: Redox-activity and Health-effects of Atmospheric Primary and Secondary aerosol (RHAPS) [Costabile, F., et al., Atmosphere 2022, 13, 704]
- @ PRIN2022: Focused eEsistome- Mobilome genes in aTmossphere-Ocean continuum (FEMTO)
- PRIN2022: Investigating atmospheric fate and Toxicological properties of Biofuels Emitted ultrafine particles with a SimulaTion chamber (IT-BEST)
- INFN-CSN5 2024: Highly characterised study of Llquid Fuel Emissions for carbonaceous aerosol source apportionment (HardLife)
- EUROCHAMP2020 (H2020: Infrastructure Activity under grant agreement No 730997)
- PON per-ACTRIS-IT (MUR-IT: PON project PIR\_00015 "Per ACTRIS IT")
- BLUE-LAB NET (F.E.S.R. FONDO EUROPEO DI SVILUPPO REGIONALE Azione POR, Regione Liguria, IT)
- ATMO-ACCESS (H2020: Infrastructure Activity under grant agreement No 101008004)
- MextGenerationEU PNRR-ITINERIS (Italian Integrated Environmental Research Infrastructures System)
- MextGenerationEU PNRR-RETURN (Multi-Risk sciEnce for resilienT commUnities undeR a changiNg climate)
- IRISCC (Integrated Research Infrastructure Services for Climate Change Risks)

#### TNAs



- @ TNAs: Survival of antimicrobial resistant strains in the air [Agarwal, V., et al., Antibiotics 2024, 13, 55]
- © TNA2023: Validation of real-time machine learning algorithms for the detection of airborne pathogenes using novel multi-dimensional UV-LIF spectrometers [Crawford, I., et al., Atmosphere 2023, 14, 1214]
- TNA2023: Investigation of aerosol forMation from contaminated waters with emerging Pollutants and model bACTeria (IPMACT)
- TNA2024: Advantage of light utilization in bacterial survival in the atmosphere (Bactlight)
- TNA2024: Interplay of BIOaerosol and HUMidity (BIOHUM)

#### **Approved**

- (##) TNA2024: Real-time methods to investigate pollen fragmentation via environmental processing
- @TNA2024: Evolution of the bacterial transcriptome following exposure to nitrous oxides (NOxIPTOME)
- TNA2024: Investigation of the aerosolization dynamics and biological interactions of GenX "forever chemicals" (AEROBIOGEN)



## THANKS!

vvernocchi@ge.infn.it



















## DOWNSTREAM VRE:

VRE services on downstream effects of environmental change

OGS\_OCE, OGS\_GEO, OGS\_CRS

23 Aprile 2024

# ITINERIS Italian Integrated Environmental Research Infrastructures System



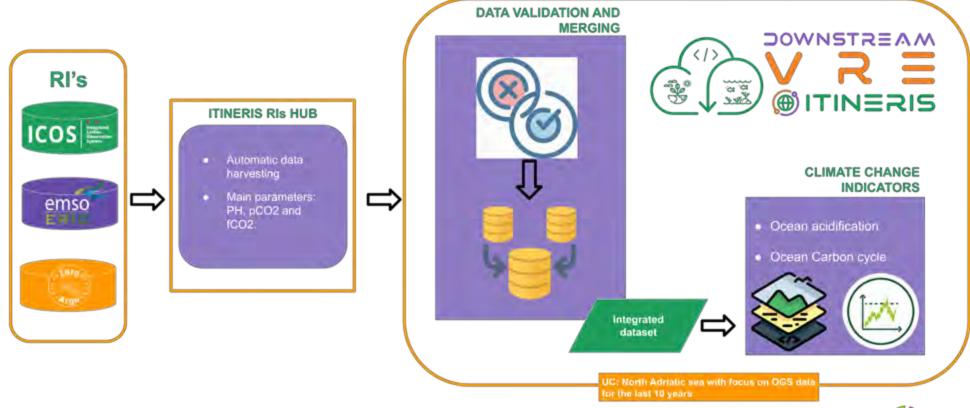








#### Marine toolbox









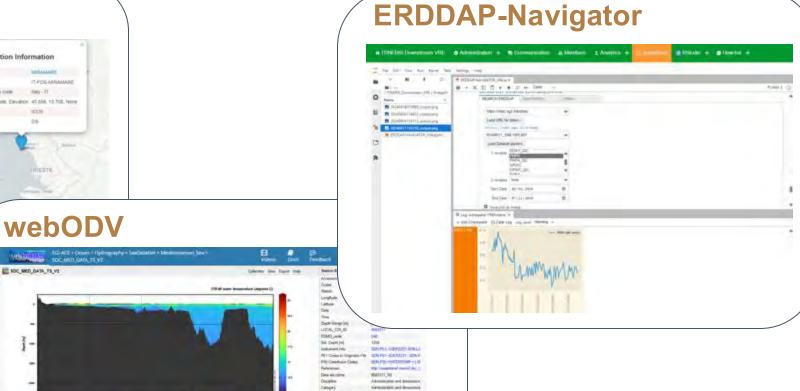


OGS

Istituto Nazionale
di Oceanografia
e di Geofisica
Sperimentale



Currently available in the downstream VRE...



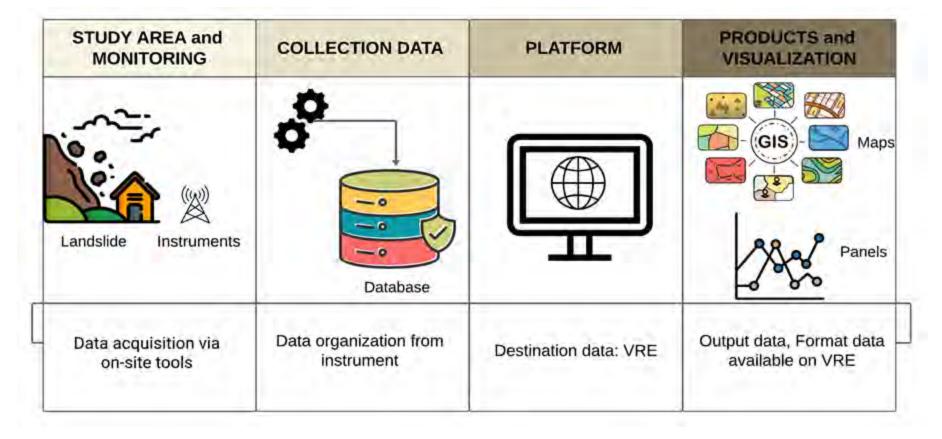








#### Land toolbox workflow

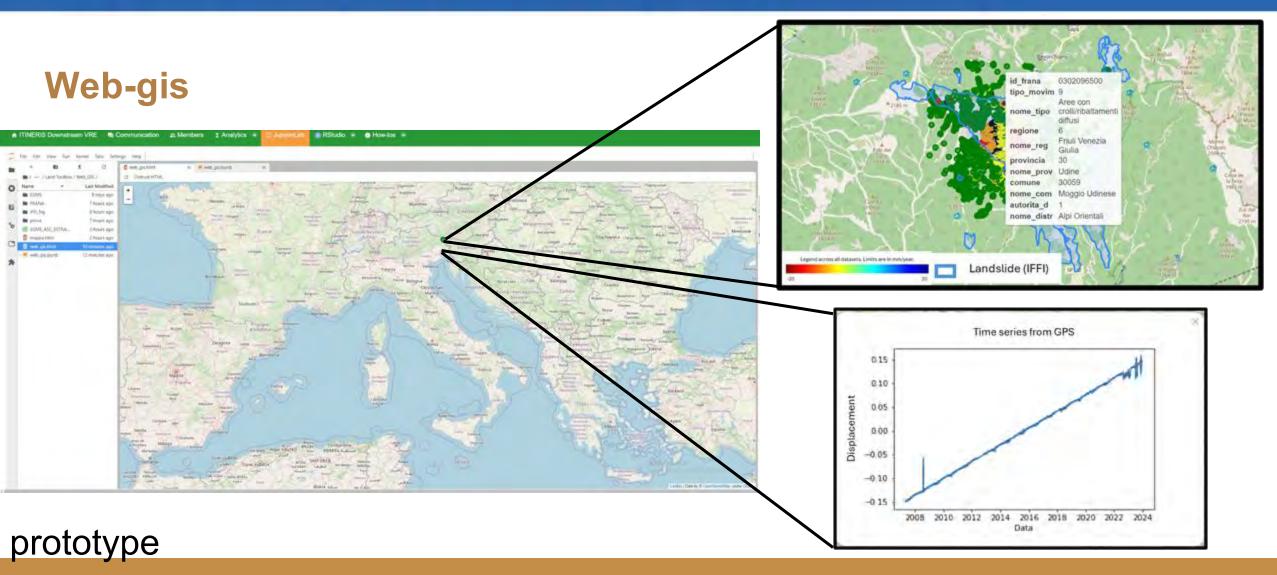














## Adoption of FAIR practices in ITINERIS Environmental Research Infrastructures



Ilaria Rosati, Enrica Nestola, Gregorio Sgrigna, Andrea Tarallo, Gianmarco Ingrosso



National Research Council – Research Institute on Terrestrial Ecosystems (URT LECCE)









### **Objectives**



#### FAIR is a set of principles to......



































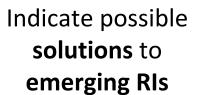




Image credit: Freepik from www.flaticon.com and ARDC https://conference.eresearch.edu.au/fair-go-new-resources-to-supportfair-data/licensed under a Creative Commons Attribution 4.0 International License

What are the FAIR-enabling practices adopted by ITINERIS RIs?





Support the **ITINERIS HUB** development



Assess the RIs alignment within and outiside **ITINERIS** 

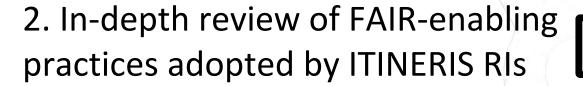
Support WPs OUs to **FAIRify** their outputs

## Methodology





1. Online survey to all the **22 RIs** (March 2023)





- 4. One-to-one interviews (June-July 2023)
  - State of the art of FAIR-enabling best practices (October 2023)
  - FIP & FAIR convergence analysis (May 2024)

### Results: State of the art



### An example of practices adopted for each principle is given.







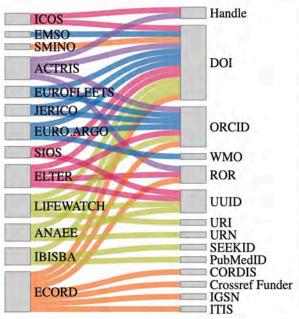


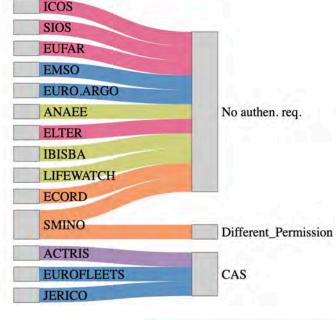


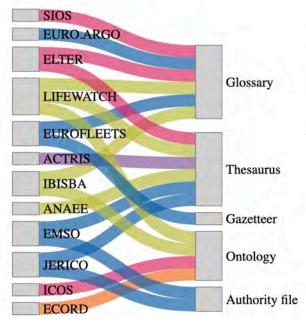


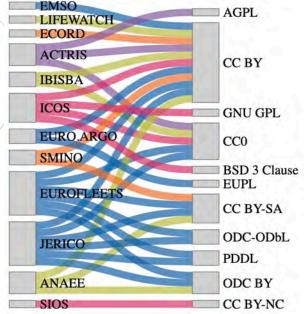


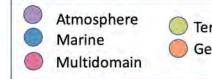


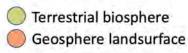












## Results: FAIR Implementation Profile (FIP) & convergence @ITINERIS analysis

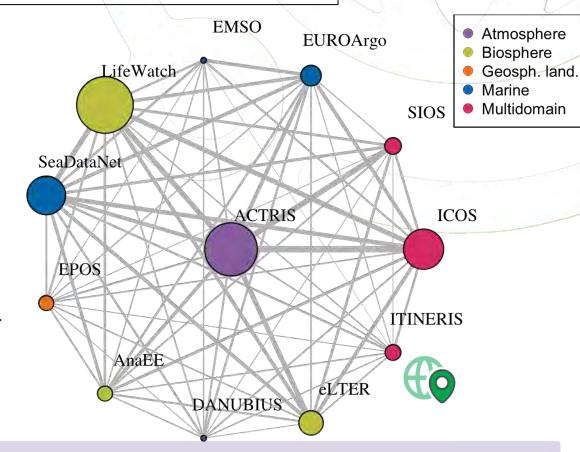
A FIP is a formal list of FAIR implementation choices declared by a specific community to fulfil one or more FAIR subprinciples.



- A first version of the ITINERIS Data Hub FIP
- The potential alignment between the FAIR-enabling practices of the ITINERIS Data Hub and other RIs, within and outside ITINERIS

#### **HOWEVER**

- The available FIPs of the different RIs could not be up-todate with the most recent implementations
- The FIP of ITINERIS Data Hub is "planned to use"



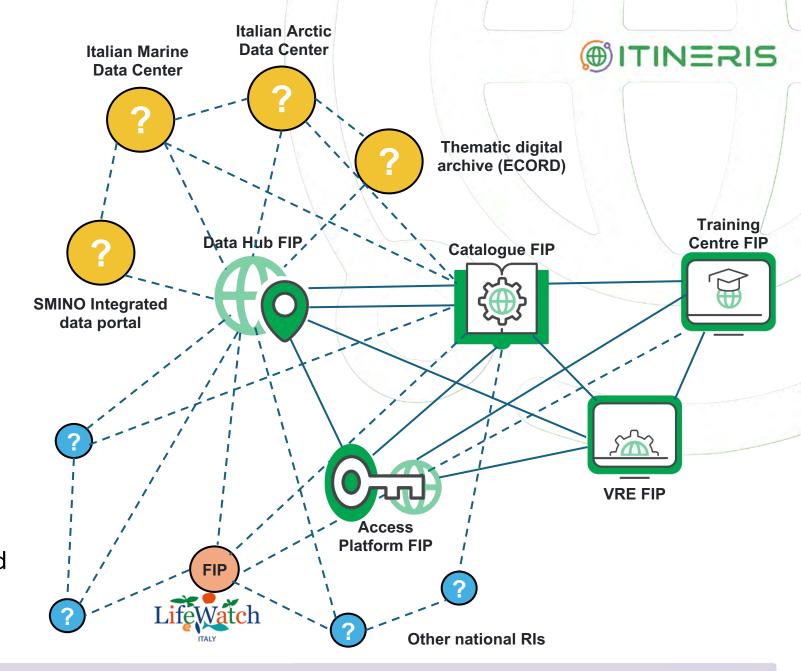
FIP Ontology, https://w3id.org/fair/fip/

## Next steps

The future work will consist of:

- Producing new or updated FIPs for the various components of the ITINERIS HUB
- Extending this practice to other national RIs or information management systems developed in ITINERIS

To provide a detailed and rigorous description of the FAIR-enabling practices adopted by different nodes and their level of FAIR convergence and connectivity.





## THANKS!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"













# WP7 Geosphere and Landsurface

Giuliana Rossi, Ilaria Catapano, Valeria Giampaolo, Giovanni Gigli and all the WP7's staff

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"









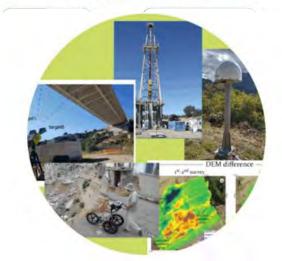


## Environmental observations on Geosphere and Landsurface

Integrating key Research Infrastructure capabilities & related datasets including: SMINO, ATLaS, ECORD-ICDP, & EUFAR

Testing cutting-edge technologies in three pilot sites: the Friuli Venezia Giulia region, Tito and Potenza in the Basilicata region







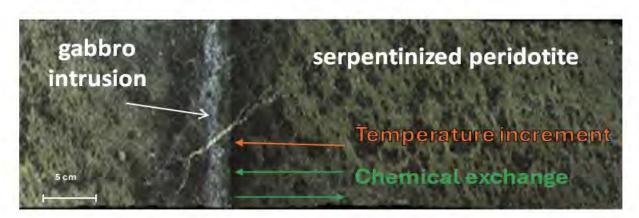






codice 102, schermo 5

## 7.1- Improving the access to the ECORD infrastructure and enabling scientific drilling micro-analysis, geochemical and site survey data sharing



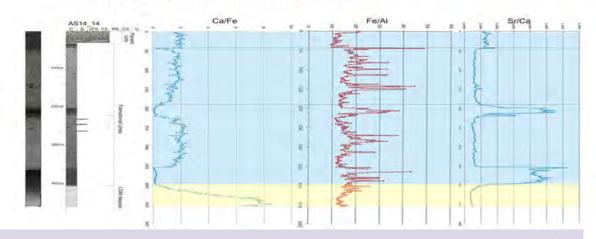
Serpentinization and gabbro intrusions: temperature and chemical exchange in leg 209 (ODP) and 357 (IODP)

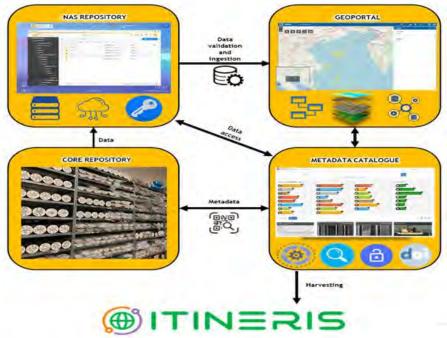
POSTER – sessione 8,

- → Oxygen isotopes thermometry: Fluorination line at IGG-CNR Pisa
- → Elemental and isotopic variations:
  - Sr, Nd, Hf isotopes (Uni-Köln, Germany)
  - In situ Si isotopes (GFZ-Potsdam, Germany)
  - Zr isotopes (CUG Wuhan, China)

XRF core scanning technique as a too for high-resolution stratigraphy.

Data derived from non-destructive analysis of a vibracore collected on the northern Adriatic: stratigraphic log, XRF-CS analysis, and magnetic susceptibility.



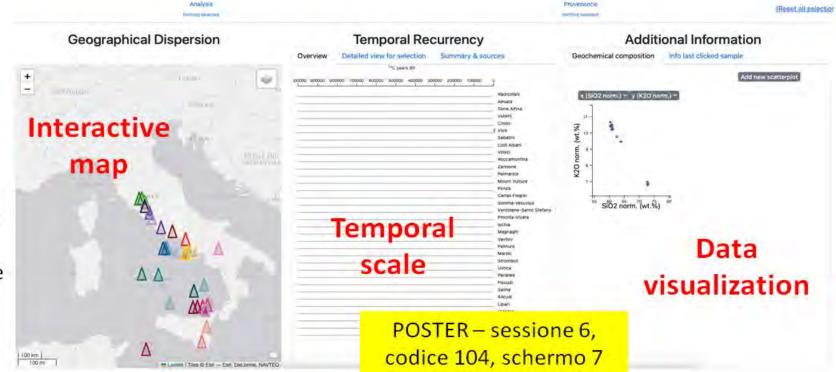


Stratigraphic, geochemical, and geochronological data of pyroclastic units from Quaternary Italian volcanoes.

Prototype online version of the database displaying the main features: an interactive map with location of the volcanic centres and outcropes/cores (left); a temporal scale (from 1.5 Ma to present; front); bi-plots diagrams showing major, minor and trace element data (right).

**Data Flow** - Cores are described and managed through the GeoNetwork metadata catalogue making them findable, accessible, and interoperable with the ITINERIS data HUB. The geoportal shows their distribution and provides some information about origin, type, overview. Data are stored in a NAS repository and are accessible through the catalogue.

POSTER – sessione 6, codice 103, schermo 6



# 7.3 Improving the access to IODP scientific borehole geophysics, subsurface structural data, and stratigraphic/lithologic samples-data sharing.

Stratigraphic/lithologic samples-data (Earth Science Department, University of Milano)

Physical catalogue completed of 8 stratigraphic wells, in progress on additional 34 wells

- 4162 samples
- 4046 smear slides
- 2459 re-usable residues from Nannofossil analyses
- 2384 re-usable residues from Foraminifera analyses
- 359 thin sections

Petrographic samples-data (Department of Earth Science, University of Pavia)

Physical catalogue completed of 2 IODP Wells and 1 ICDP well.

- Rock samples
- Thins sections

Catalogue includes bibliographic references of published data

Digital data temporarily stored in Excel files before using the Mobile Drilling Information System (m-DIS)





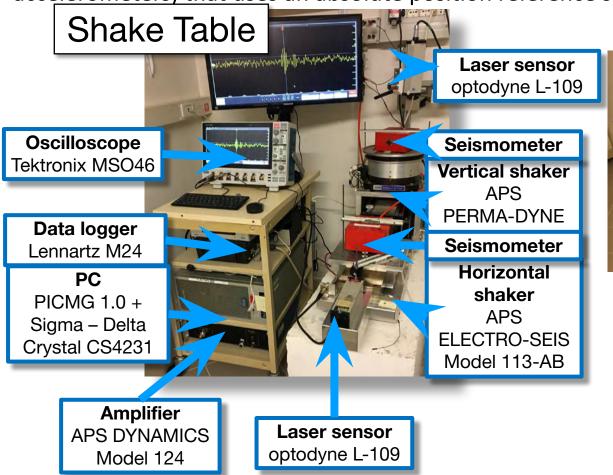


## 7.7 Integrated facility for the access to SMINO observations



The SPEKTRA Q-Leap CS Vibration Table is a system for calibrating seismometers (velocimeters and

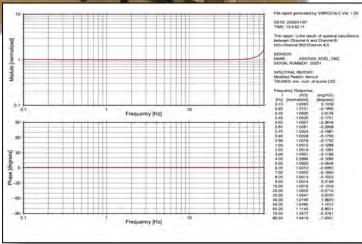
accelerometers) that uses an absolute position reference system with sample measurement from a laser device.



### Calibration laboratory



### Calibration repor



Acquired, base prepared, to be activated in the next weeks.

## 7.8 Data integrated facility for the access to geophysical observations on the subsurface



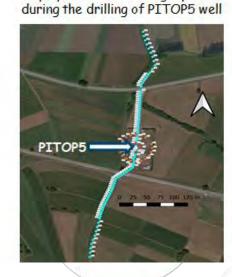
PITOP FACILITY IN TRAVESIO (PN, ITALY)





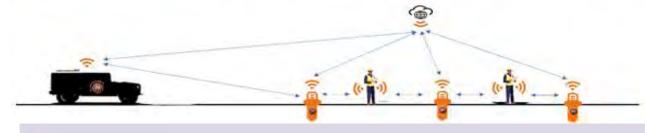
#### NuSeis Geophones (mono and three components):

- Long battery life: providing up to 45 days of continuous operation.
- · Wireless recording units
- · GNSS and BLE comms: easy deployment and retrieval.
- SEG standard data formats: compatible with processing softwares.



Deployment of surface geophones

New seismic nodes 1C and 3C, acquired and tested while drilling the new borehole.



## 7.7 Integrated facility for the access to SMINO observations



Fiber interrogators: acquired, waiting for the delivery

Ocean Bottom seismograph: acquired, waiting for the installation at the MEDA (coordination with WP5).

## 7.8 Data integrated facility for the access to geophysical observations on the subsurface

Fiber cable and interrogators: acquired, waiting for the delivery



## 7.9 Integrated facility for accessible airborne geophysical observations.

Very high resolution magnetic and GPR drones: acquired: to be tested on Marmolada Glacier (Dolomites, Italy) in July;

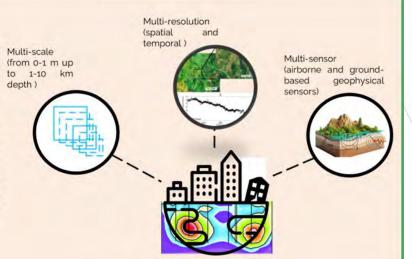
Magnetic sensors for aero-magnetic surveys; gamma-ray sensors; strapdown gravity system: tender opened.





#### **SCIENTIFIC GOALS**

Development of an integrated approach for surface, subsurface and built-up characterization in urban areas and monitoring of civil infrastructure of strategic interest to mitigate the effects of natural and man-made hazards



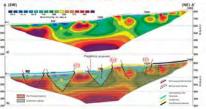


#### Airborne Hyperspectral Imaging Systems (VNIR-SWIR)

- Continuous spectral coverage from 400nm to 2500nm
- Spatial resolution of about 30/40 cm in the VNIR and about 1m in the SWIR







## New electrical resistivity tomography system

**exploration and land surface** monitoring (CNR IMAA)

- Different spatial e temporal resolution by using 2D and 3D tomographic methods,
   investigation depth (from
- investigation depth (from 0-1 m up to 1-10 km depth time-lapse acquisition,
- ML data analysis techniques

#### New GB-SAR and GB-RAR



- monitoring surface deformation
- studying the static and dynamic behavior of strategic infrastructure
- Spatial resolution of at least 0.75 m

#### Seimic data from new sesimic sensors and fiber optic interrogator

- Nodal systems consisting into velocimeter and accelerometers,
- DAS maximum interrogation range ≥ 50 km
- ML data analysis techniques

## 7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)



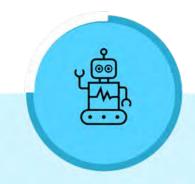


Next-generation researchers and technologists

100%

Engagement of new personnel dedicated to these topics:

- 1 researcher,
- 1 technologist,
- 2 Phd students.



**Cutting-edge equipment** 

50%

Cutting-edge geophysical equipment for the subsoil investigation within the depth range 0-10 km and the analysis of near-surface-soil-infrastructure dynamical interactions.

Sensors operating in short-wave infrared (SWIR) spectral range for land surface monitoring.



Pilot sites: Potenza and Tito urban areas

30%

Areas affected by high seismic and hydrogeological risk.
Furthermore, the industrial area of Tito is heavily polluted and is classified as national interest site (SIN).



FAIR data access In synergy with Activity 7.5 and WP2

30%

Integration with SMINO and ATLaS IR.

Webgis tool: it will include, for the first time, also raw datasets from on land geophysical surveys, airborne data, and the newly generated fiber optical strain measurements.



### exploration and land surface monitoring (CNR IMAA)

#### FIRST TESTS OF GEOPHYSICAL EQUIPMENT

POSTER - session 6 Code 105, screen 8

Syscal Terra (IRIS Instruments) for mapping the groundwater table at the industrial site of Tito affected by groundwater pollution

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito Company and a conductive lower area

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito Company and a conductive lower area

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito Company

Transition 2 one between a highly resistive upper area and a conductive lower area

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Transition 2 one between a highly resistive upper area and a conductive lower area

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito CNR in c.da S.Loja of Fi

Electrical resistivity and seismic noise measurements in the historic center of Benevento town for seismic protection of historical buildings



3D ERT using Syscal Terra (IRIS Instruments)



Structural monitoring using SENTINEL GEO (LUNITEK)

Vincenzo Serlenga
Tests and applications of seismic arrays in different urban contexts



### exploration and land surface monitoring (CNR IMAA)

One of the pilot sites of WP7 is the city of Potenza in Basilicata region (southern Italy), a predominantly mountainous zone affected by high seismic and hydrogeological risks.



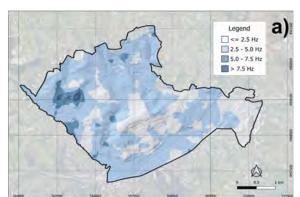
(rights reserved to Gianluca Labella)

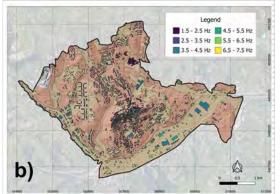
#### FIRST ACTIVITIES AT PILOT SITES

ORAL - 16:46 - 16:53
Giovanni Gangone (PhD student)
Soil-building resonance effect in the urban area of the city of Potenza (Southern Italy)

### SOIL-BUILDING RESONANCE EFFECTS OF THE CITY OF POTENZA

- ☐ To estimate the fundamental resonance frequency of the soils of the city of Potenza, we acquired 300 microtremor signals.
- □ 153 buildings of the city of Potenza were monitored by microtremors acquisitions. Their selection was performed by taking into account different characteristics (i.e. height of the building, area in plan of the building, construction type, tipology of outcropping soils).





a) Iso-frequency map of the soil of the city of Potenza, b) Iso-frequency map of the buildings of Potenza.



exploration and land surface monitoring (CNR IMAA)

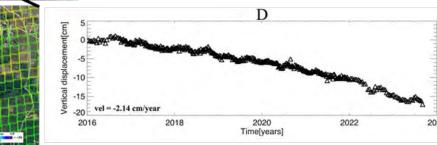
#### **FIRST ACTIVITIES AT PILOT SITES**

# InSAR Vertical displacement of POTENZA and TITO in therm of soil deformation for the identification of test area affected by landslides

In Basilicata, hydrogeological instability is widespread and is an extremely serious and important issue because urban settlements are involved in many cases.



## Urban and periurban area of POTENZA

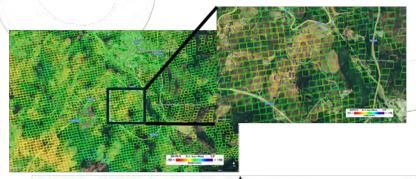


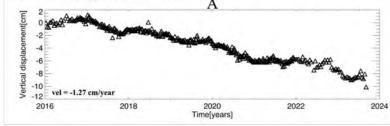
#### STAKEHOLDERS INVOLVEMENT



The landslide has been attended to by the mayor of the municipality of Tito and is part of the 118 landslides project of the Basilicata order of geologists.

## Urban and periurban area of TITO





## 7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)



#### ON GOING and FUTURE RESEARCH ACTIVITIES

Instrumentation of the selected slope affected by landslides for geophysical monitoring

Machine learning techniques applications to link geophysical and subsoil properties

Multi-parameter, multi-scale and multi-resolution experiment in the test areas and demonstration to stakeholders in collaboration with OGS, CNR IREA all interested partner of WP7

Transfer of the integrated approach developed into ITINERIS project to other activities such as the microzonation of Campi Flegrei for the Italian Civil Protection



Exploitation and optimization of technologies for the Soil-Subsoil System (SSS) observation by using two technological assets:

#### AIRBORNE SYNTHETIC APERTURE RADAR

The system aims at improving the multi-parameter observation of the surface processes, f.i., mass movements, subsidence and ground deformations. It will be mounted on-board an aircraft and include a compact, multi-capability radar system allowing different data acquisition modes (i.e. single-pass interferometry and polarimetry); a Flight Management System, for planning flight missions and navigating the aircraft for precise SAR data acquisitions; a GNSS/IMU system providing both real-time position and attitude information to the radar; computing resources for raw data storing and subsequent post-processing on ground.

#### Advantages:

- high operational flexibility
- suitable for reaching inaccessible areas
- short revisiting time

#### **GROUND-BASED INSTRUMENTATIONS**

Multi-platform and multi-scale geophysical facility for SSS imaging, electromagnetic characterization (electric contrast and magnetic susceptibility), and measurement of its temperature and strain.

The facility includes proximal and on-site instruments for data acquisition (magnetometers, gradiometer, multi-antenna ground penetrating radar and optical backscatter reflectometer) and will gain of the expertise of IREA researchers in setting-up state of art processing methodologies for 2D and 3D imaging. The facility is useful for urban and structural geology, agronomy, shallow geothermal exploration, terrain instability surveys.

#### Advantages:

- high resolution imaging of subsoil
- shallow and deep surveys
- synoptic image of the environmental system



#### AIRBORNE SYNTHETIC APERTURE RADAR

#### Airborne SAR system infrastructure

## Multiband SAR system (under contract)



Flight Management System (acquired)



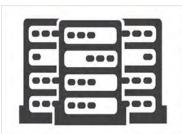
Source: https://www.topoflight.com

## GNSS/INS system PwrPak7D-E2 (acquired)



Source: https://novatel.com

## Computing resources (planned)

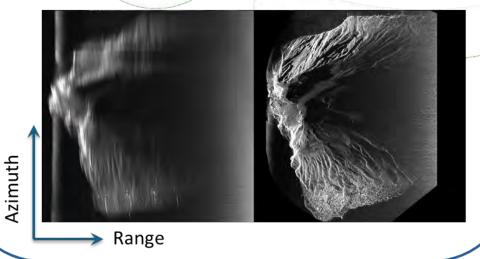


Source: https://shorturl.at/7lKoV

#### **Developed activities:**

- Review and training on the new softwares Novatel and Flight Management System TopoFlight.
- Adaptation of focusing algorithms for processing data collected by the new instrumentation.

#### Range Compressed Focussed





#### **GROUND-BASED INSTRUMENTATIONS**

(purchase at the final steps – testing and payment)



<u>Magnetometer</u>: system for the total magnetic field and its vertical gradient measurement equipped with 2 QuSpin Gen-2 sensors, which guarantee data acquisition with 200 – 1000 Hz sampling rate and 0.003 nT sensitivity.



**Zond Aero LF:** drone based ultralight ground penetrating radar system equipped with 3 unshielded dipole antennas working at 3 different central frequencies: 100 MHz, 150 MHz, 300 MHz.



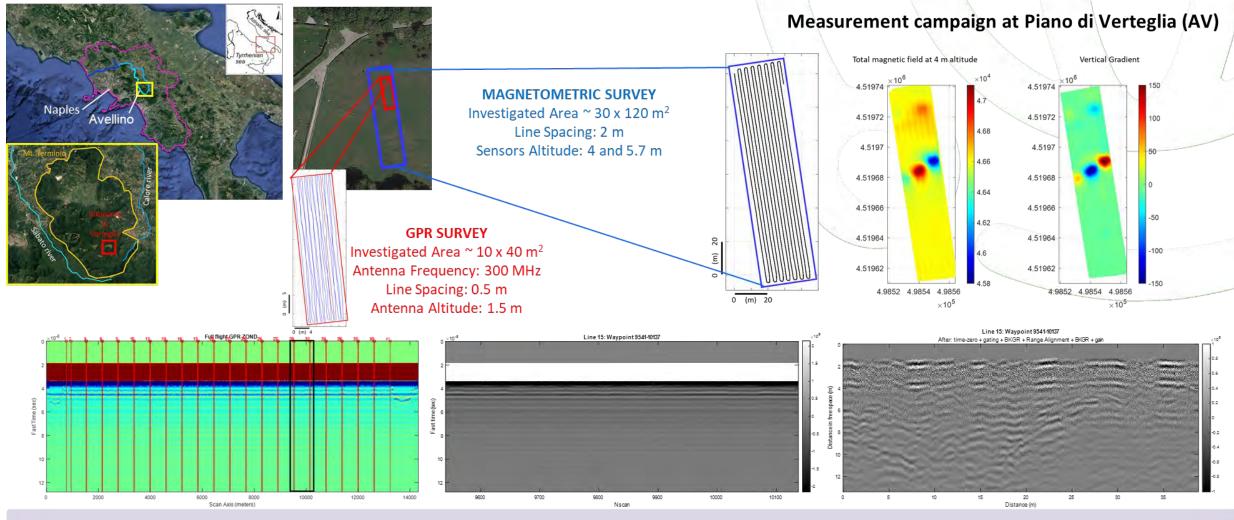
Geoscope MkIV equipped with the array ground coupled G0908: multi-channel multi-frequency ground penetrating radar (GPR) for high-density 3D data capturing. Thanks to the step-frequency technology, the system enables optimal penetration and highest resolution simultaneously by sweeping through a wide frequency range (40 MHz – 3GHz) with only one single antenna array.



OBR 4600 Optical Backscatter Reflectometer: device for fiber optic distributed strain and temperature sensing, which is able to measure strain and temperature over 2 km distance range with no dead zone, with high spatial resolution (few mm) and high speed (3Hz).



#### **GROUND-BASED INSTRUMENTATIONS – FIRST ON FIELD TRIALS**

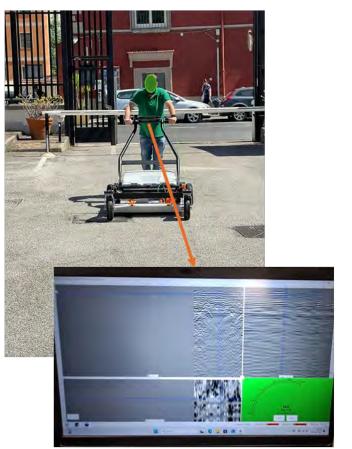




#### **GROUND-BASED INSTRUMENTATIONS – PRELIMINARY TEST & RESEARCH ACTIVITIES**

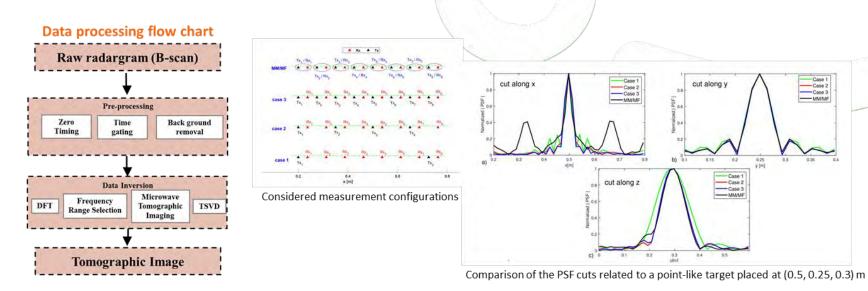
#### Multi-channel multi-frequency ground penetrating radar (GPR)

#### Preliminary test @CNR-IREA



#### Research activities

A data processing strategy specifically designed to handle multi-view and multi-static GPR data has been designed and a study devoted to establish the relationship among the number of transmitting antennas and the imaging capabilities has been presented at EGU 2024 [1] and in a paper under review [2]



[1] F. Soldovieri, G. Gennarelli, G. Esposito, G. Ludeno, I. Catapano, Non-destructive surveys via microwave tomography enhanced multichannel GPR, EGU General Assembly 2024 [2] M. Masoodi, G. Gennarelli, F. Soldovieri, I. Catapano, Multiview Multistatic vs Multimonostatic 3D GPR imaging: a comparison, submitted to Remote Sensing



#### ON GOING RESEARCH ACTIVITIES

#### vs an optimized use of Airborne SAR system infrastructure

Adaptation of the interferometric SAR calculation chain for data processing collected by the new instrumentation

#### vs an integrated use of electromagnetic methodologies for subsoils investigations

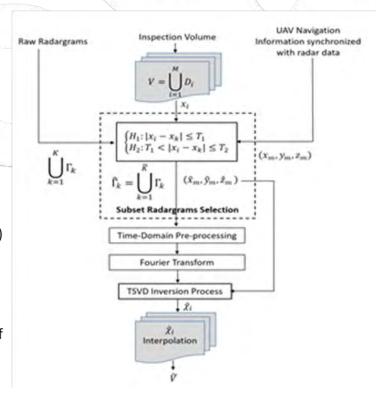
WP7 Poster "Development of an integrated electromagnetic sensing system for environment characterization" Francesco Mercogliano - 10/07/2024 Session 8 16:40 - 17:00 (Poster code: 106 - Monitor: 9)

#### vs an optimized use of drone based Ground Penetrating Radar

Design, Implementation and validation of data processing approaches accounting for flight positioning information (Microwave Tomography Imaging approaches compensating platform deviations from the nominal flight trajectory)

#### vs an optimized use of multi-channel Ground Penetrating Radar

Design, Implementation and validation of advanced data processing approaches exploiting the increased amount of gathered data for improving the imaging performances



### 7.6 Integrated platform for surface movements monitoring





Developing an integrated platform to distribute data for the observation and the forecasting of ground deformations, including the output from advanced monitoring and hazard forecasting models in a multi-scale perspective

#### **ATLAS - Advanced Technologies for Landslides**

ATLaS (Advanced Technologies for Landslides) is a research infrastructure established aiming to develop leading-edge methodologies (<u>Mission</u>) for the prevention and management of ground instabilities. The objective of reducing the hydrogeological risk is pursued conducting innovative <u>research activities</u> in which the use of state-of-the-art <u>instruments</u> plays a pivotal role.







Projects

Instruments

#### ATLAS Research Infrastructure includes:

- The Civil Protection Center
- The UNESCO Chair for Prevention and Sustainable Management of Geohydrological Hazards
- The Department of Earth Sciences

Research Activities

### 7.6 Scientific Instrumentation





3D printer



Fixed-wing UAV







**UAV** Hyperspectral cameras



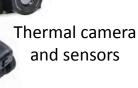
Mobile Slam Lidar



ITINERIS

Long Range TLS







Mobile Unit



Wireless Sensor Network





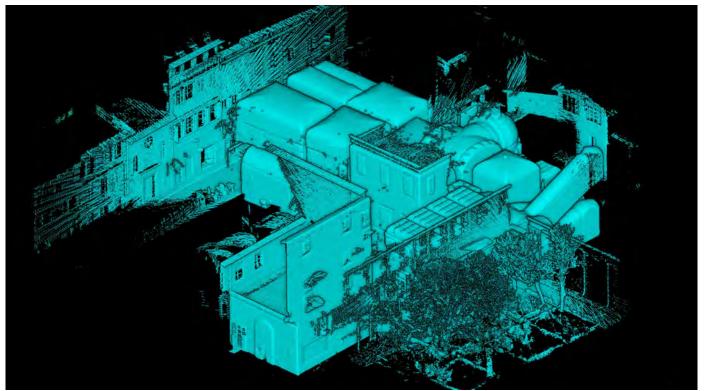
**GB InSAR** Doppler Radar



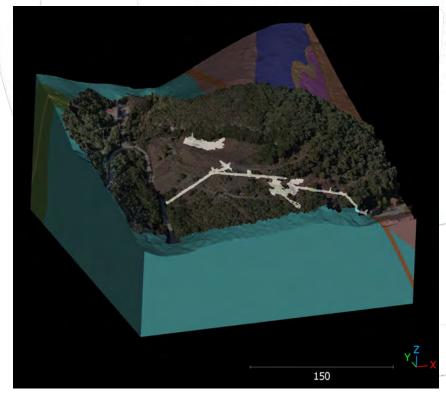
**Underwater ROV** 

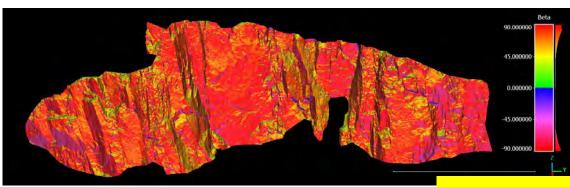


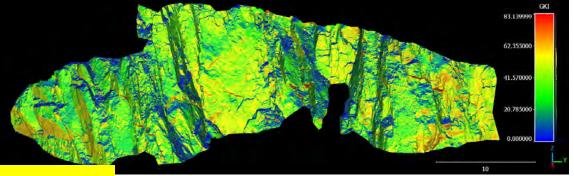
## 7.6 Training and experimental campaigns



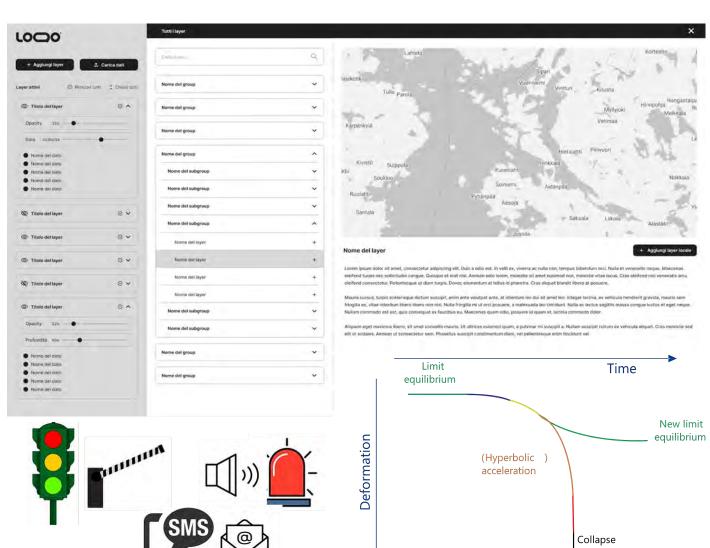








## 7.6 Data Sharing and Early Warning Platform

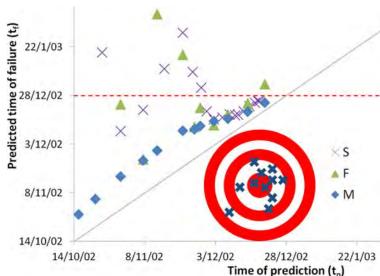


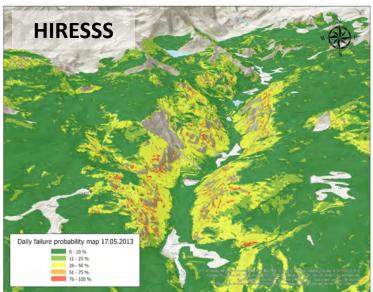


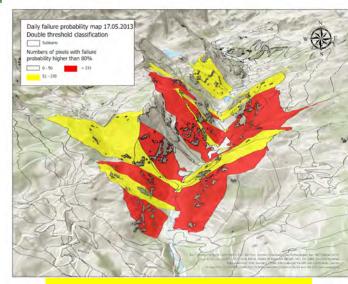
- Display and share planimetric and 3D data
- Real-time monitoring data
- Customised diagrams
- Dashboard for emergency management
- Tools for quickly defining risk scenarios
- Real-time forecasting algorithms
- Definition of alarm thresholds
- Threshold exceeding notifications

## 7.6 Forecasting Models





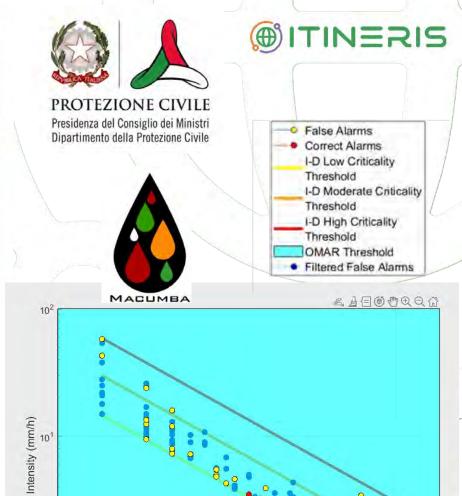




POSTER - Sessione 8 Codice 109, Schermo 12

10<sup>0</sup>

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10<sup>1</sup>

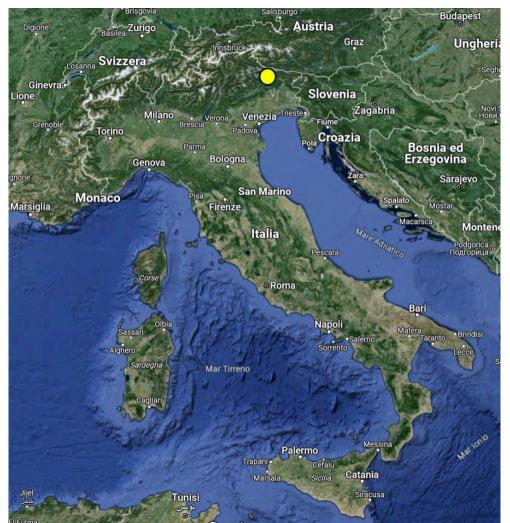
Duration (h)

10<sup>2</sup>

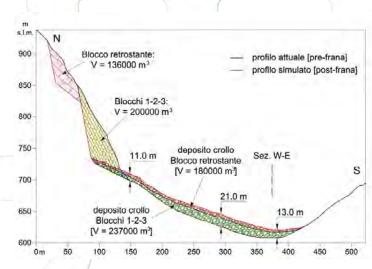
### 7.6 Selected Test Site



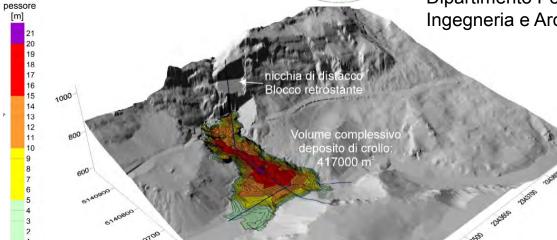








Università degli studi di Udine Dipartimento Politecnico Ingegneria e Architettura, 2018





## THANKS!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment

3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"











# WP7 Geosphere and Landsurface

Giuliana Rossi, Ilaria Catapano, Valeria Giampaolo, Giovanni Gigli and all the WP7's staff

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System (D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"









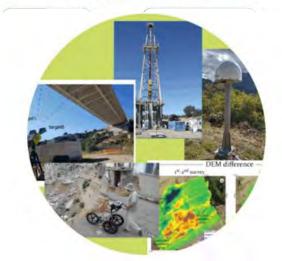


## Environmental observations on Geosphere and Landsurface

Integrating key Research Infrastructure capabilities & related datasets including: SMINO, ATLaS, ECORD-ICDP, & EUFAR

Testing cutting-edge technologies in three pilot sites: the Friuli Venezia Giulia region, Tito and Potenza in the Basilicata region







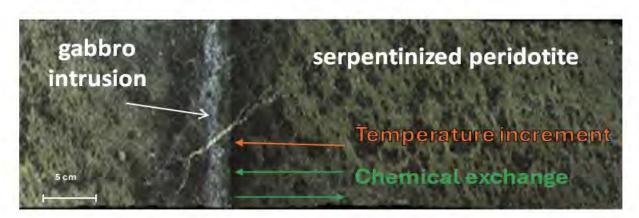






codice 102, schermo 5

## 7.1- Improving the access to the ECORD infrastructure and enabling scientific drilling micro-analysis, geochemical and site survey data sharing



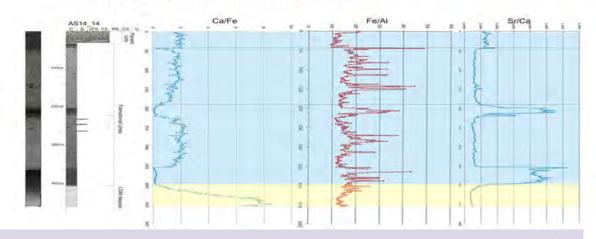
Serpentinization and gabbro intrusions: temperature and chemical exchange in leg 209 (ODP) and 357 (IODP)

POSTER – sessione 8,

- → Oxygen isotopes thermometry: Fluorination line at IGG-CNR Pisa
- → Elemental and isotopic variations:
  - Sr, Nd, Hf isotopes (Uni-Köln, Germany)
  - In situ Si isotopes (GFZ-Potsdam, Germany)
  - Zr isotopes (CUG Wuhan, China)

XRF core scanning technique as a too for high-resolution stratigraphy.

Data derived from non-destructive analysis of a vibracore collected on the northern Adriatic: stratigraphic log, XRF-CS analysis, and magnetic susceptibility.



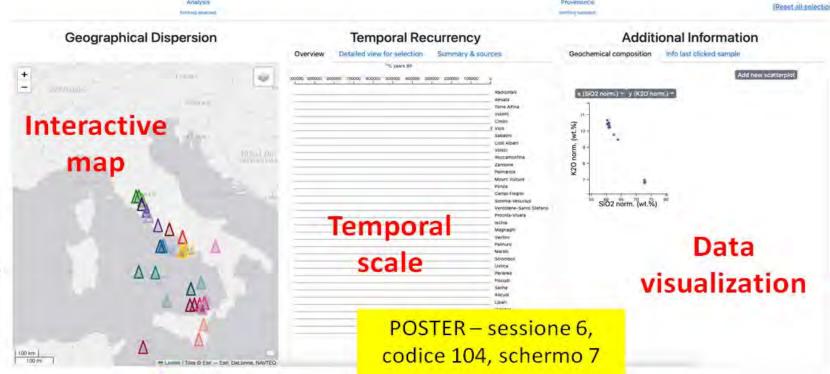


Stratigraphic, geochemical, and geochronological data of pyroclastic units from Quaternary Italian volcanoes.

Prototype online version of the database displaying the main features: an interactive map with location of the volcanic centres and outcropes/cores (left); a temporal scale (from 1.5 Ma to present; front); bi-plots diagrams showing major, minor and trace element data (right).

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POSTER – sessione 6, codice 103, schermo 6



# 7.3 Improving the access to IODP scientific borehole geophysics, subsurface structural data, and stratigraphic/lithologic samples-data sharing.

Stratigraphic/lithologic samples-data (Earth Science Department, University of Milano)

Physical catalogue completed of 8 stratigraphic wells, in progress on additional 34 wells

- 4162 samples
- 4046 smear slides
- 2459 re-usable residues from Nannofossil analyses
- 2384 re-usable residues from Foraminifera analyses
- 359 thin sections

Petrographic samples-data (Department of Earth Science, University of Pavia)

Physical catalogue completed of 2 IODP Wells and 1 ICDP well.

- Rock samples
- Thins sections

Catalogue includes bibliographic references of published data

Digital data temporarily stored in Excel files before using the Mobile Drilling Information System (m-DIS)





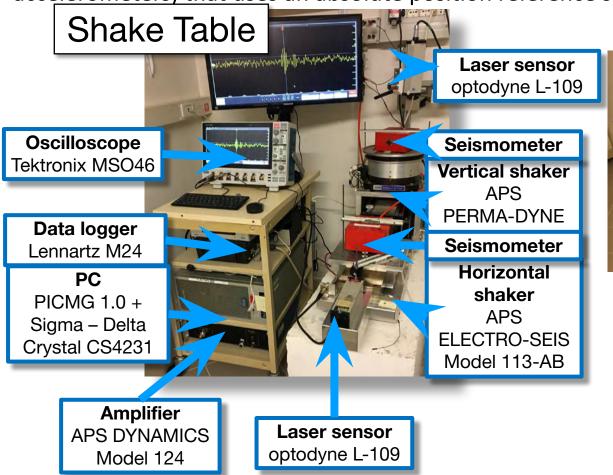


## 7.7 Integrated facility for the access to SMINO observations



The SPEKTRA Q-Leap CS Vibration Table is a system for calibrating seismometers (velocimeters and

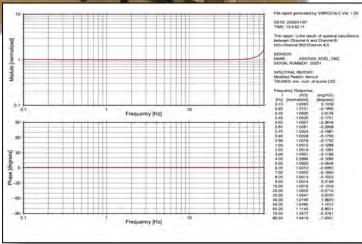
accelerometers) that uses an absolute position reference system with sample measurement from a laser device.



### Calibration laboratory



### Calibration repor



Acquired, base prepared, to be activated in the next weeks.

## 7.8 Data integrated facility for the access to geophysical observations on the subsurface



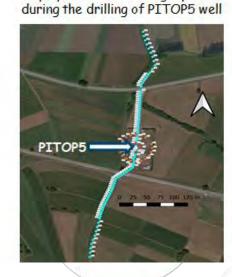
PITOP FACILITY IN TRAVESIO (PN, ITALY)





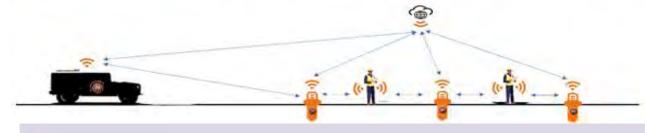
#### NuSeis Geophones (mono and three components):

- Long battery life: providing up to 45 days of continuous operation.
- · Wireless recording units
- · GNSS and BLE comms: easy deployment and retrieval.
- SEG standard data formats: compatible with processing softwares.



Deployment of surface geophones

New seismic nodes 1C and 3C, acquired and tested while drilling the new borehole.



## 7.7 Integrated facility for the access to SMINO observations



Fiber interrogators: acquired, waiting for the delivery

Ocean Bottom seismograph: acquired, waiting for the installation at the MEDA (coordination with WP5).

## 7.8 Data integrated facility for the access to geophysical observations on the subsurface

Fiber cable and interrogators: acquired, waiting for the delivery



## 7.9 Integrated facility for accessible airborne geophysical observations.

Very high resolution magnetic and GPR drones: acquired: to be tested on Marmolada Glacier (Dolomites, Italy) in July;

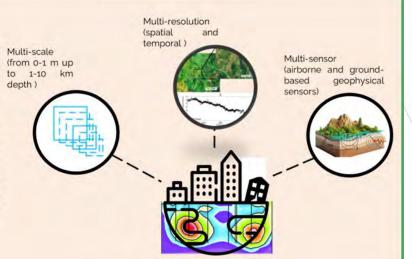
Magnetic sensors for aero-magnetic surveys; gamma-ray sensors; strapdown gravity system: tender opened.





#### **SCIENTIFIC GOALS**

Development of an integrated approach for surface, subsurface and built-up characterization in urban areas and monitoring of civil infrastructure of strategic interest to mitigate the effects of natural and man-made hazards



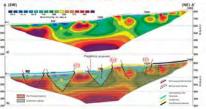


#### Airborne Hyperspectral Imaging Systems (VNIR-SWIR)

- Continuous spectral coverage from 400nm to 2500nm
- Spatial resolution of about 30/40 cm in the VNIR and about 1m in the SWIR







## New electrical resistivity tomography system

**exploration and land surface** monitoring (CNR IMAA)

- Different spatial e temporal resolution by using 2D and 3D tomographic methods,
   investigation depth (from
- investigation depth (from 0-1 m up to 1-10 km depth time-lapse acquisition,
- ML data analysis techniques

#### New GB-SAR and GB-RAR



- monitoring surface deformation
- studying the static and dynamic behavior of strategic infrastructure
- Spatial resolution of at least 0.75 m

#### Seimic data from new sesimic sensors and fiber optic interrogator

- Nodal systems consisting into velocimeter and accelerometers,
- DAS maximum interrogation range ≥ 50 km
- ML data analysis techniques

## 7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)



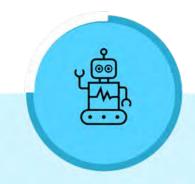


Next-generation researchers and technologists

100%

Engagement of new personnel dedicated to these topics:

- 1 researcher,
- 1 technologist,
- 2 Phd students.



**Cutting-edge equipment** 

50%

Cutting-edge geophysical equipment for the subsoil investigation within the depth range 0-10 km and the analysis of near-surface-soil-infrastructure dynamical interactions.

Sensors operating in short-wave infrared (SWIR) spectral range for land surface monitoring.



Pilot sites: Potenza and Tito urban areas

30%

Areas affected by high seismic and hydrogeological risk.
Furthermore, the industrial area of Tito is heavily polluted and is classified as national interest site (SIN).



FAIR data access In synergy with Activity 7.5 and WP2

30%

Integration with SMINO and ATLaS IR.

Webgis tool: it will include, for the first time, also raw datasets from on land geophysical surveys, airborne data, and the newly generated fiber optical strain measurements.



### exploration and land surface monitoring (CNR IMAA)

#### FIRST TESTS OF GEOPHYSICAL EQUIPMENT

POSTER - session 6 Code 105, screen 8

Syscal Terra (IRIS Instruments) for mapping the groundwater table at the industrial site of Tito affected by groundwater pollution

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito Company and a conductive lower area

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito Company and a conductive lower area

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito Company and a conductive lower and interpretation

Zero meter

Transition zone between a highly resistive upper area and a conductive lower area

Electrical resistivity tomography performed near the CNR in c.da S.Loja of Fito Company and a conductive lower area

Transition zone between a highly resistive upper area and a conductive lower area

Zero meter

Transition zone between a highly resistive upper area and a conductive lower area

Zero meter

Transition zone between a highly resistive upper area and a conductive lower area

Zero meter

Transition zone between a highly resistive upper area and a conductive lower area

Zero meter

Electrical resistivity and seismic noise measurements in the historic center of Benevento town for seismic protection of historical buildings



3D ERT using Syscal Terra (IRIS Instruments)



Structural monitoring using SENTINEL GEO (LUNITEK)

Vincenzo Serlenga
Tests and applications of seismic arrays in different urban contexts



### exploration and land surface monitoring (CNR IMAA)

One of the pilot sites of WP7 is the city of Potenza in Basilicata region (southern Italy), a predominantly mountainous zone affected by high seismic and hydrogeological risks.



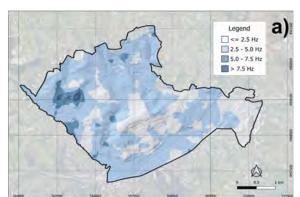
(rights reserved to Gianluca Labella)

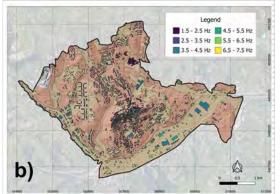
#### FIRST ACTIVITIES AT PILOT SITES

ORAL - 16:46 - 16:53
Giovanni Gangone (PhD student)
Soil-building resonance effect in the urban area of the city of Potenza (Southern Italy)

### SOIL-BUILDING RESONANCE EFFECTS OF THE CITY OF POTENZA

- ☐ To estimate the fundamental resonance frequency of the soils of the city of Potenza, we acquired 300 microtremor signals.
- □ 153 buildings of the city of Potenza were monitored by microtremors acquisitions. Their selection was performed by taking into account different characteristics (i.e. height of the building, area in plan of the building, construction type, tipology of outcropping soils).





a) Iso-frequency map of the soil of the city of Potenza, b) Iso-frequency map of the buildings of Potenza.



exploration and land surface monitoring (CNR IMAA)

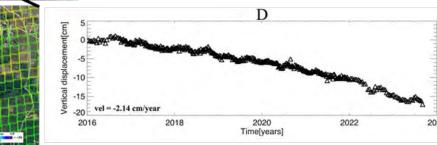
#### **FIRST ACTIVITIES AT PILOT SITES**

## InSAR Vertical displacement of POTENZA and TITO in therm of soil deformation for the identification of test area affected by landslides

In Basilicata, hydrogeological instability is widespread and is an extremely serious and important issue because urban settlements are involved in many cases.



## Urban and periurban area of POTENZA

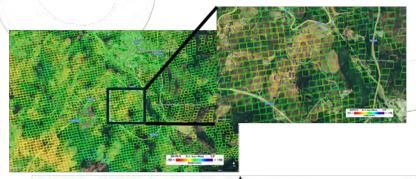


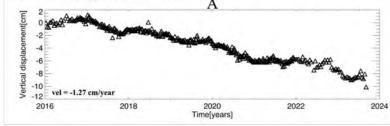
#### STAKEHOLDERS INVOLVEMENT



The landslide has been attended to by the mayor of the municipality of Tito and is part of the 118 landslides project of the Basilicata order of geologists.

## Urban and periurban area of TITO





## 7.4 Upgrade and networking of the **ground-based and airborne** facilities for **geophysical exploration and land surface** monitoring (CNR IMAA)



#### ON GOING and FUTURE RESEARCH ACTIVITIES

Instrumentation of the selected slope affected by landslides for geophysical monitoring

Machine learning techniques applications to link geophysical and subsoil properties

Multi-parameter, multi-scale and multi-resolution experiment in the test areas and demonstration to stakeholders in collaboration with OGS, CNR IREA all interested partner of WP7

Transfer of the integrated approach developed into ITINERIS project to other activities such as the microzonation of Campi Flegrei for the Italian Civil Protection



Exploitation and optimization of technologies for the Soil-Subsoil System (SSS) observation by using two technological assets:

#### AIRBORNE SYNTHETIC APERTURE RADAR

The system aims at improving the multi-parameter observation of the surface processes, f.i., mass movements, subsidence and ground deformations. It will be mounted on-board an aircraft and include a compact, multi-capability radar system allowing different data acquisition modes (i.e. single-pass interferometry and polarimetry); a Flight Management System, for planning flight missions and navigating the aircraft for precise SAR data acquisitions; a GNSS/IMU system providing both real-time position and attitude information to the radar; computing resources for raw data storing and subsequent post-processing on ground.

#### Advantages:

- high operational flexibility
- suitable for reaching inaccessible areas
- short revisiting time

#### **GROUND-BASED INSTRUMENTATIONS**

Multi-platform and multi-scale geophysical facility for SSS imaging, electromagnetic characterization (electric contrast and magnetic susceptibility), and measurement of its temperature and strain.

The facility includes proximal and on-site instruments for data

The facility includes proximal and on-site instruments for data acquisition (magnetometers, gradiometer, multi-antenna ground penetrating radar and optical backscatter reflectometer) and will gain of the expertise of IREA researchers in setting-up state of art processing methodologies for 2D and 3D imaging. The facility is useful for urban and structural geology, agronomy, shallow geothermal exploration, terrain instability surveys.

#### Advantages:

- high resolution imaging of subsoil
- shallow and deep surveys
- synoptic image of the environmental system



#### AIRBORNE SYNTHETIC APERTURE RADAR

#### Airborne SAR system infrastructure

## Multiband SAR system (under contract)



Flight Management System (acquired)



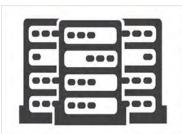
Source: https://www.topoflight.com

## GNSS/INS system PwrPak7D-E2 (acquired)



Source: https://novatel.com

## Computing resources (planned)

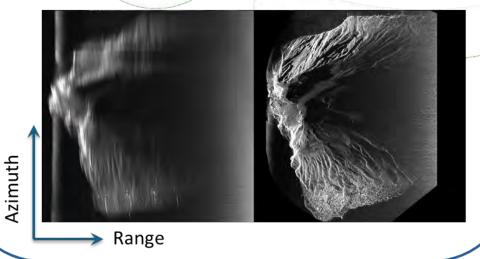


Source: https://shorturl.at/7lKoV

#### **Developed activities:**

- Review and training on the new softwares Novatel and Flight Management System TopoFlight.
- Adaptation of focusing algorithms for processing data collected by the new instrumentation.

#### Range Compressed Focussed





#### **GROUND-BASED INSTRUMENTATIONS**

(purchase at the final steps – testing and payment)



<u>Magnetometer</u>: system for the total magnetic field and its vertical gradient measurement equipped with 2 QuSpin Gen-2 sensors, which guarantee data acquisition with 200 – 1000 Hz sampling rate and 0.003 nT sensitivity.



**Zond Aero LF:** drone based ultralight ground penetrating radar system equipped with 3 unshielded dipole antennas working at 3 different central frequencies: 100 MHz, 150 MHz, 300 MHz.



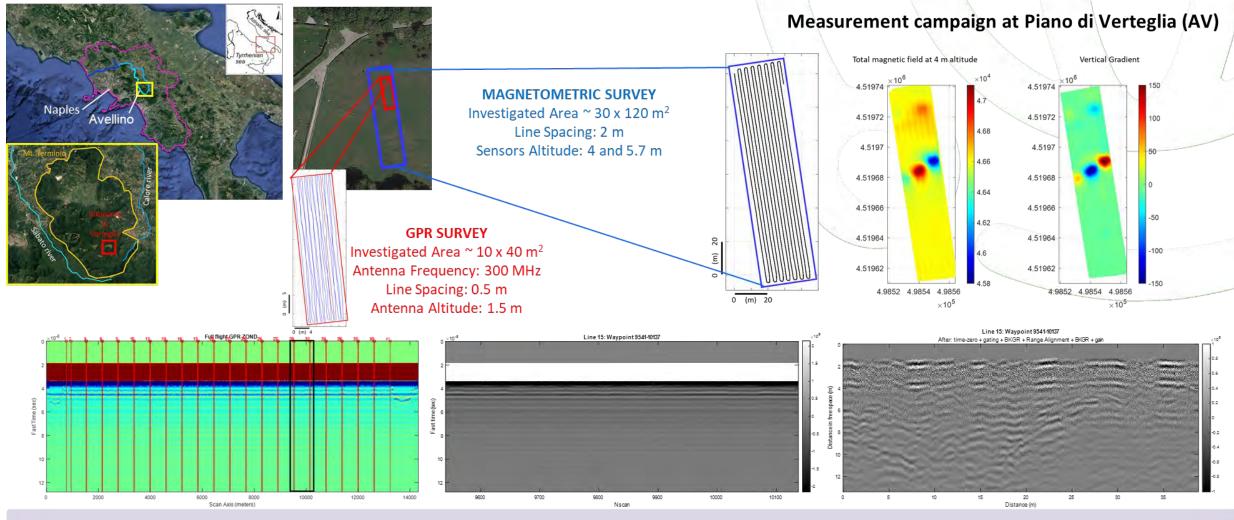
Geoscope MkIV equipped with the array ground coupled G0908: multi-channel multi-frequency ground penetrating radar (GPR) for high-density 3D data capturing. Thanks to the step-frequency technology, the system enables optimal penetration and highest resolution simultaneously by sweeping through a wide frequency range (40 MHz – 3GHz) with only one single antenna array.



OBR 4600 Optical Backscatter Reflectometer: device for fiber optic distributed strain and temperature sensing, which is able to measure strain and temperature over 2 km distance range with no dead zone, with high spatial resolution (few mm) and high speed (3Hz).



#### **GROUND-BASED INSTRUMENTATIONS – FIRST ON FIELD TRIALS**

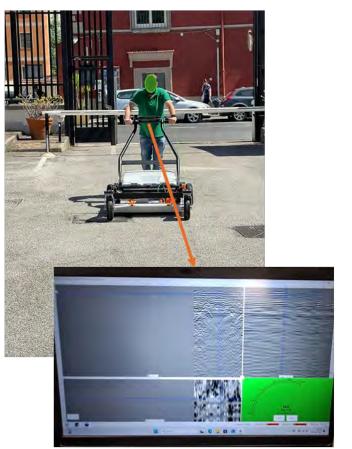




#### **GROUND-BASED INSTRUMENTATIONS – PRELIMINARY TEST & RESEARCH ACTIVITIES**

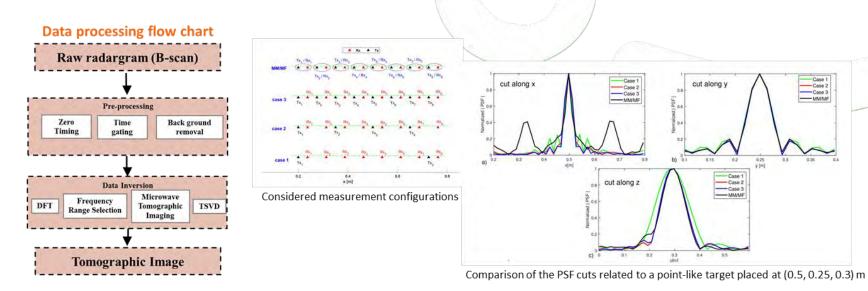
#### Multi-channel multi-frequency ground penetrating radar (GPR)

#### Preliminary test @CNR-IREA



#### Research activities

A data processing strategy specifically designed to handle multi-view and multi-static GPR data has been designed and a study devoted to establish the relationship among the number of transmitting antennas and the imaging capabilities has been presented at EGU 2024 [1] and in a paper under review [2]



[1] F. Soldovieri, G. Gennarelli, G. Esposito, G. Ludeno, I. Catapano, Non-destructive surveys via microwave tomography enhanced multichannel GPR, EGU General Assembly 2024 [2] M. Masoodi, G. Gennarelli, F. Soldovieri, I. Catapano, Multiview Multistatic vs Multimonostatic 3D GPR imaging: a comparison, submitted to Remote Sensing



#### ON GOING RESEARCH ACTIVITIES

#### vs an optimized use of Airborne SAR system infrastructure

Adaptation of the interferometric SAR calculation chain for data processing collected by the new instrumentation

#### vs an integrated use of electromagnetic methodologies for subsoils investigations

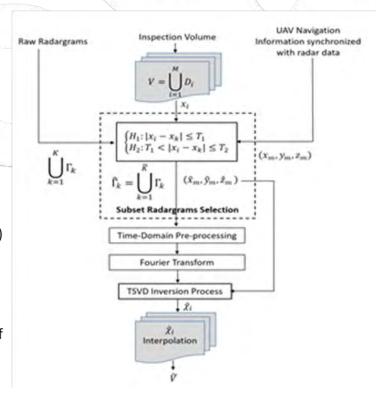
WP7 Poster "Development of an integrated electromagnetic sensing system for environment characterization" Francesco Mercogliano - 10/07/2024 Session 8 16:40 - 17:00 (Poster code: 106 - Monitor: 9)

#### vs an optimized use of drone based Ground Penetrating Radar

Design, Implementation and validation of data processing approaches accounting for flight positioning information (Microwave Tomography Imaging approaches compensating platform deviations from the nominal flight trajectory)

#### vs an optimized use of multi-channel Ground Penetrating Radar

Design, Implementation and validation of advanced data processing approaches exploiting the increased amount of gathered data for improving the imaging performances



### 7.6 Integrated platform for surface movements monitoring





Developing an integrated platform to distribute data for the observation and the forecasting of ground deformations, including the output from advanced monitoring and hazard forecasting models in a multi-scale perspective

#### **ATLAS - Advanced Technologies for Landslides**

ATLaS (Advanced Technologies for Landslides) is a research infrastructure established aiming to develop leading-edge methodologies (<u>Mission</u>) for the prevention and management of ground instabilities. The objective of reducing the hydrogeological risk is pursued conducting innovative <u>research activities</u> in which the use of state-of-the-art <u>instruments</u> plays a pivotal role.







Projects

Instruments

#### ATLAS Research Infrastructure includes:

- The Civil Protection Center
- The UNESCO Chair for Prevention and Sustainable Management of Geohydrological Hazards
- The Department of Earth Sciences

Research Activities

### 7.6 Scientific Instrumentation





3D printer



Fixed-wing UAV







**UAV** Hyperspectral cameras



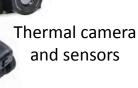
Mobile Slam Lidar



ITINERIS

Long Range TLS







Mobile Unit



Wireless Sensor Network





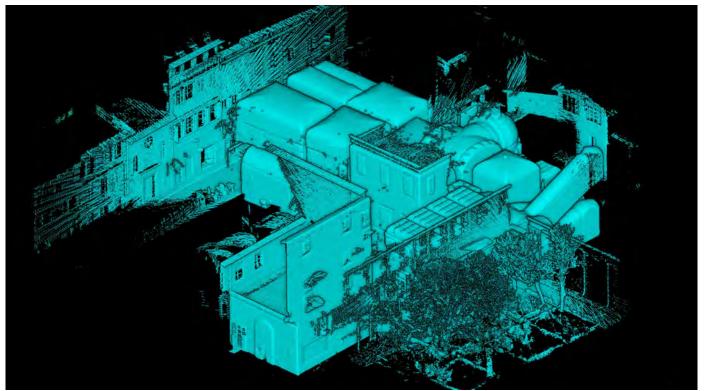
**GB InSAR** Doppler Radar



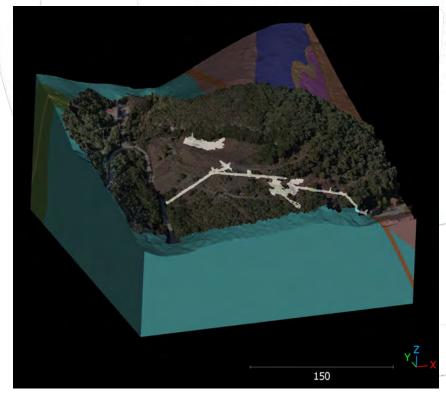
**Underwater ROV** 

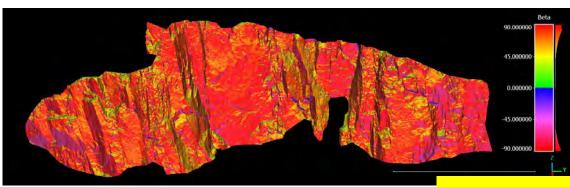


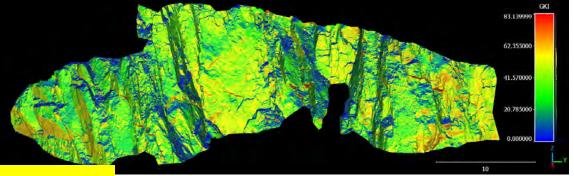
## 7.6 Training and experimental campaigns



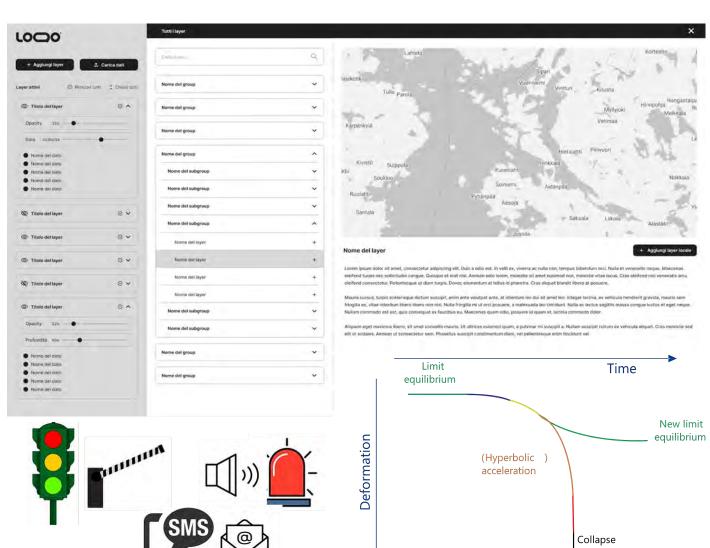








## 7.6 Data Sharing and Early Warning Platform

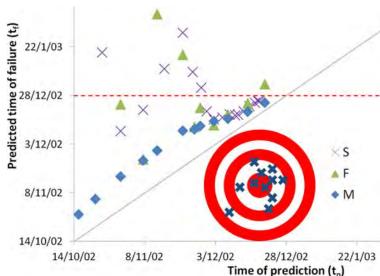


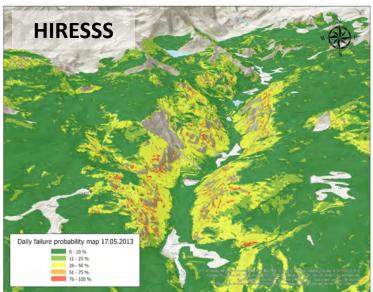


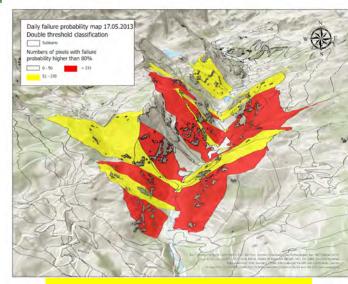
- Display and share planimetric and 3D data
- Real-time monitoring data
- Customised diagrams
- Dashboard for emergency management
- Tools for quickly defining risk scenarios
- Real-time forecasting algorithms
- Definition of alarm thresholds
- Threshold exceeding notifications

## 7.6 Forecasting Models





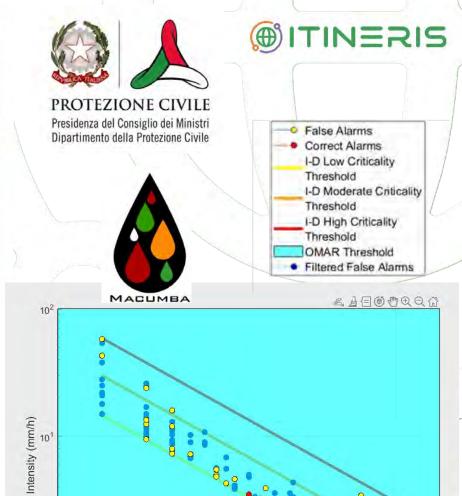




POSTER - Sessione 8 Codice 109, Schermo 12

10<sup>0</sup>

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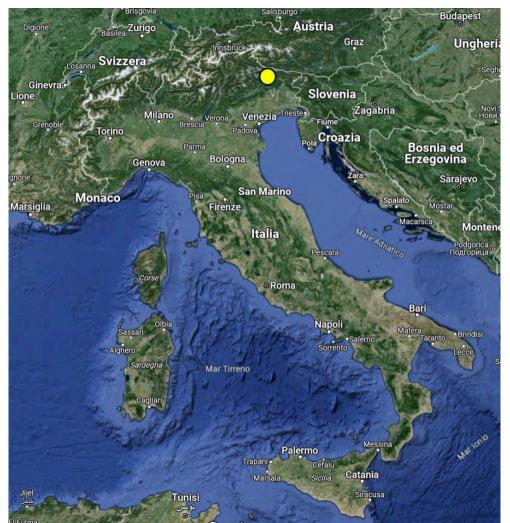
Duration (h)

10<sup>2</sup>

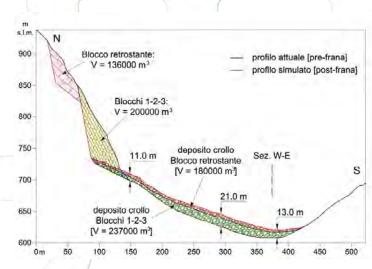
### 7.6 Selected Test Site



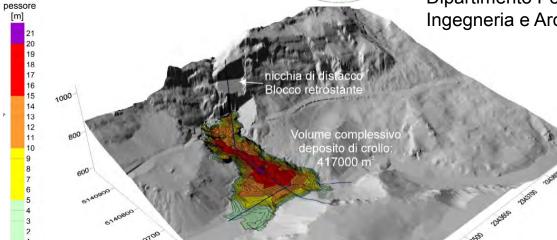








Università degli studi di Udine Dipartimento Politecnico Ingegneria e Architettura, 2018





## THANKS!

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3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"







