PEEX Seminar at the ACCC Impact Week (April 2025)
Tuesday, 22 April 2025

ARIANET research activities

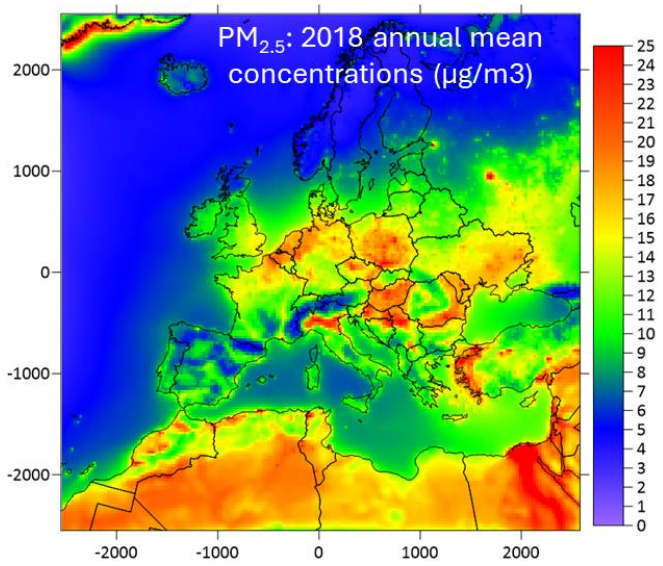
Sandro Finardi
(together with Alessandro D'Ausilio, Umberto Giuriato, Camillo Silibello and Giuseppe Calori)

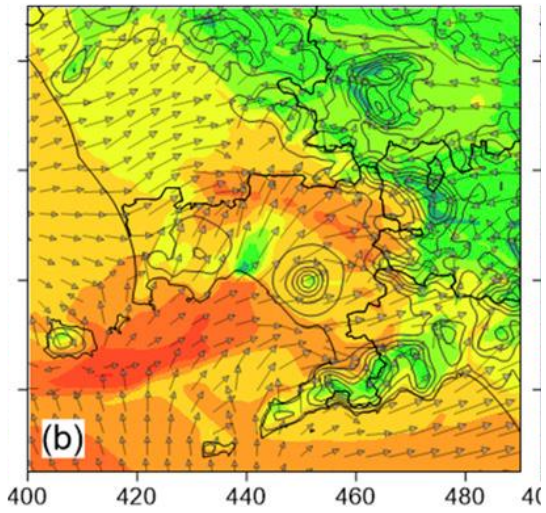
suez ARIANET

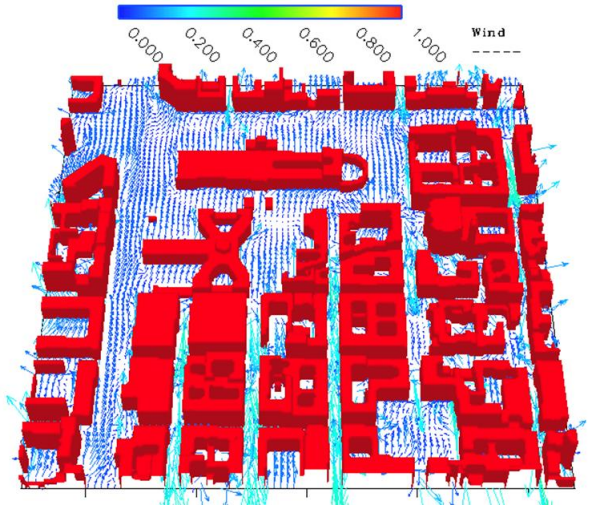
A consulting company operating since 2001

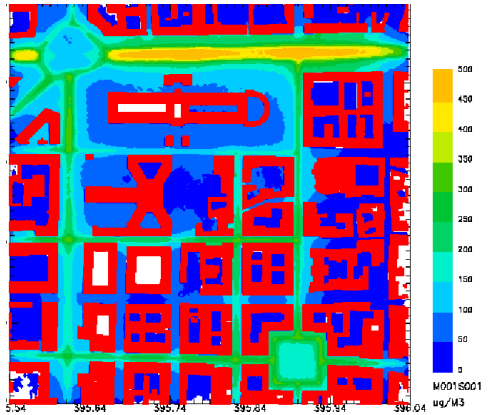
https://www.aria-net.it/

Atmosperic Modelling from regional to local scale









Supporting public bodies, research institutions and private clients

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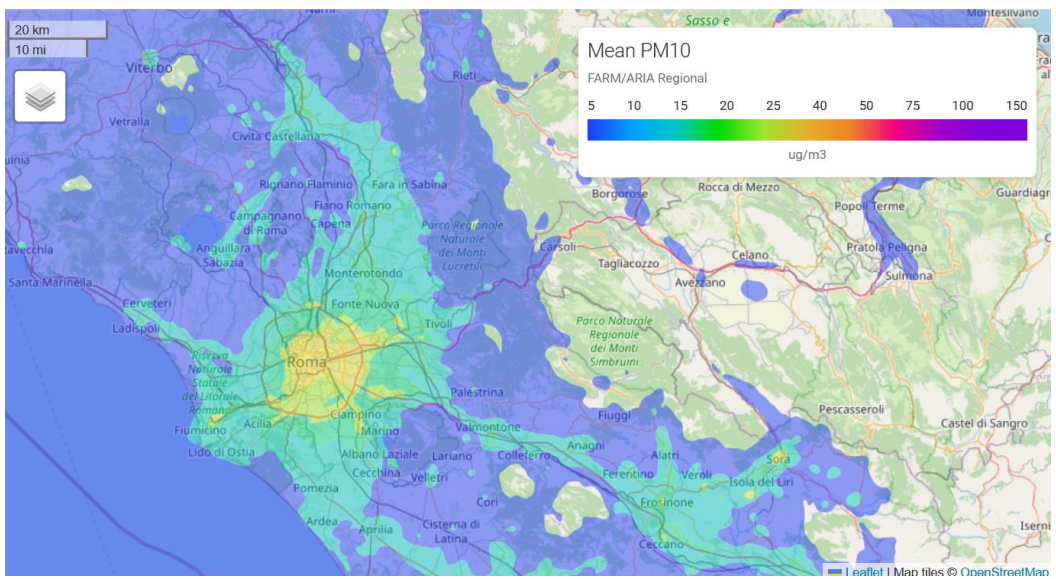
ARIANET research activities

Pan-Eurasian Experiment PEEX

ARIANET *aims to bridge research to applications*

implement best available knowledge to support air quality management, forecast and environmental protection



Cooperation with research institutions:

Charles University

University of Hertfordshire

IOWA

FINNISH METEOROLOGICAL INSTITUTE

ENEA

CNR ISAC

Italian National Research Council

INAIL
ISTITUTO NAZIONALE PER L'ASSICURAZIONE CONTRO GLI INFORTUNI SUL LAVORO

Research projects:

- EC Framework programs
- LIFE program

COST Actions

International initiatives:

- FAIRMODE
- EURODELTA

National projects

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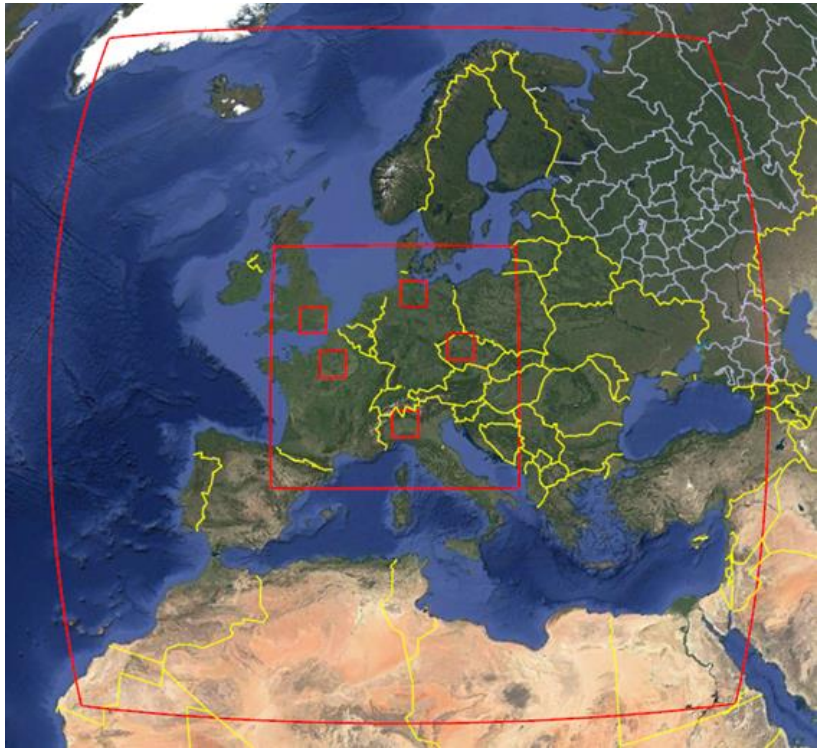
Non-CO_2 Forcers and their Climate, Weather, Air Quality and Health Impacts

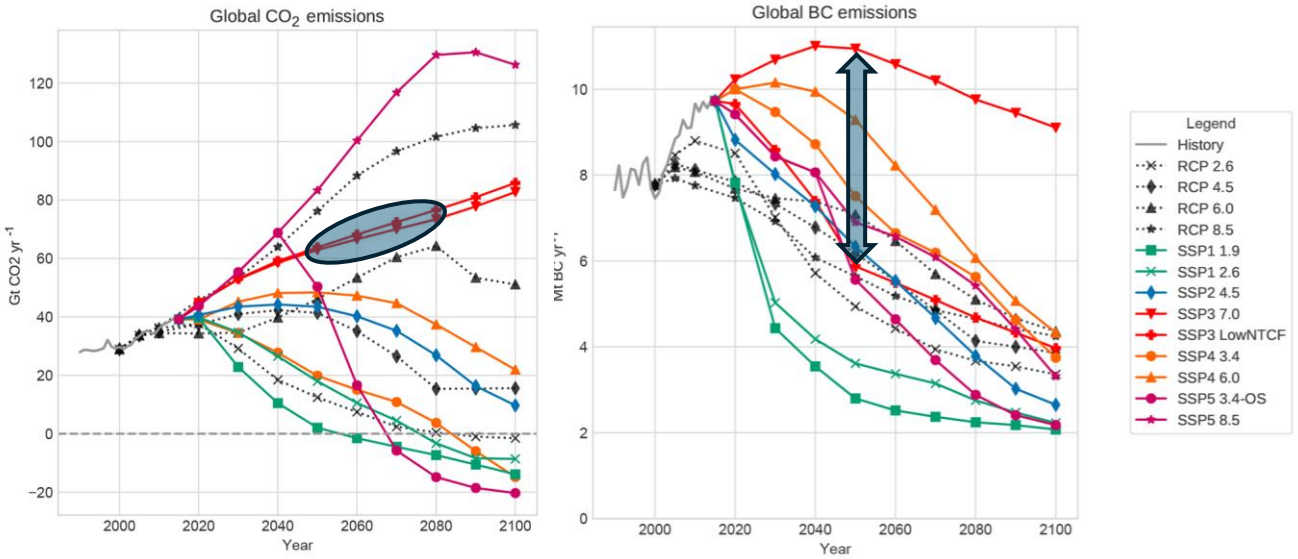
FOCI

Regional scale climate and atm. composition:

- *historical period (WP4)*
- *SSP 3.7.0 & SSP 3.7.0 low-NTCF (WP6)*

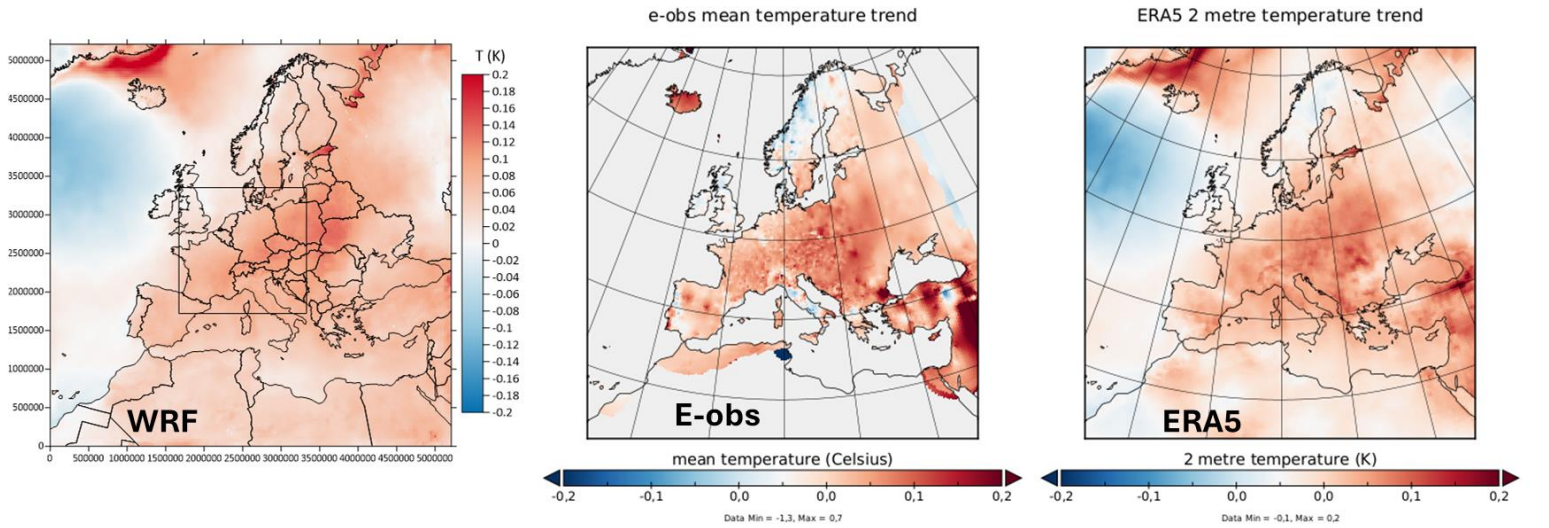


https://www.project-foci.eu/



Gidden et al., 2019, https://doi.org/10.5194/gmd-12-1443-2019, 2019.

WRF results: T trend (deg/year) during the historical period (2005-2019)

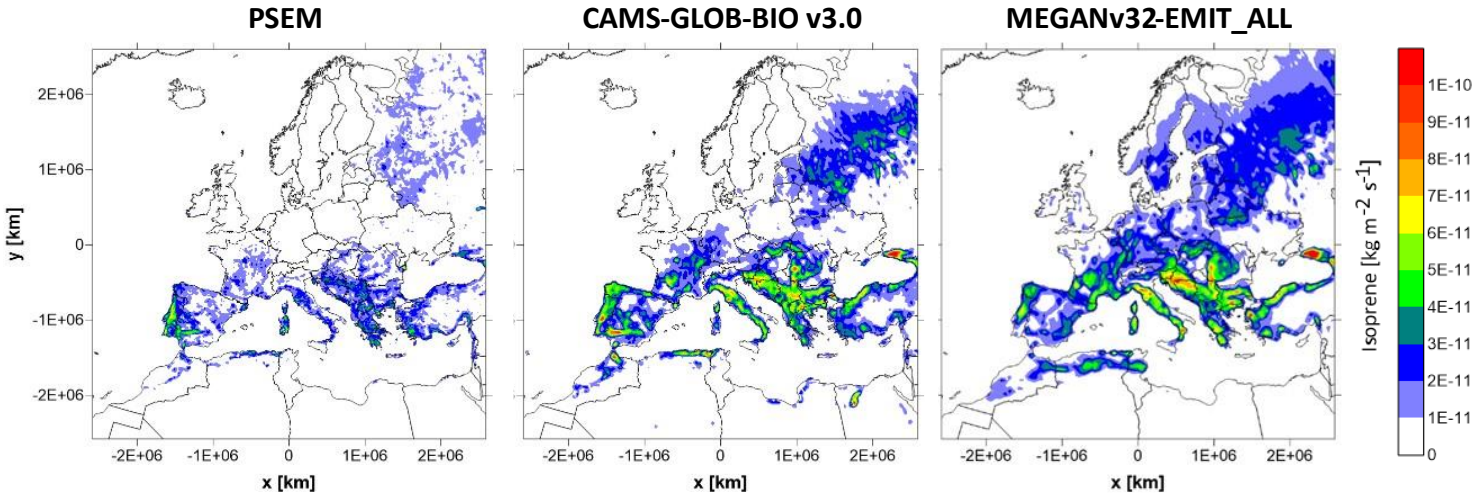


Co-funded by the European Union

Non-CO_2 Forcers and their Climate, Weather, Air Quality and Health Impacts

Effect of species-specific emission modelling on BVOC emission estimate (WP5)

Isoprene annual mean emission (2000-2019)



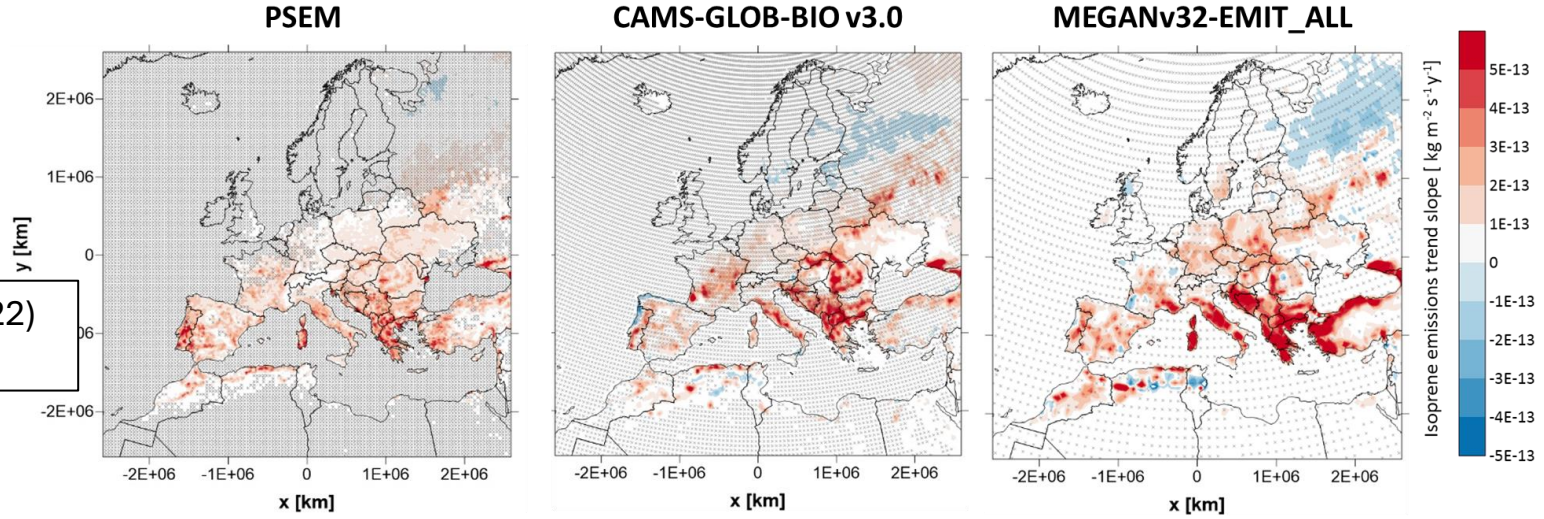
Plant Specific Emission Model (PSEM)

Ciccioli et al., 2023,
https://doi.org/10.1016/j.agrformet.2022.109255

Forest cover mapping:

- EFI: 1 km, 20 tree species distribution over Europe (Brus et al. 2011)
- ESA-CCI: 300m, global annual land cover

Isoprene annual mean trend (2000-2019)



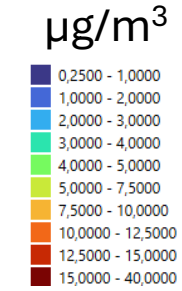
* CAMS-GLOB-BIO v3.0 (MEGAN V2.1), Sindelarova et al (2022)
\+ MEGANv32-EMIT_ALL (MEGAN V3.2) Wang et al (2024)

Co-funded by the European Union

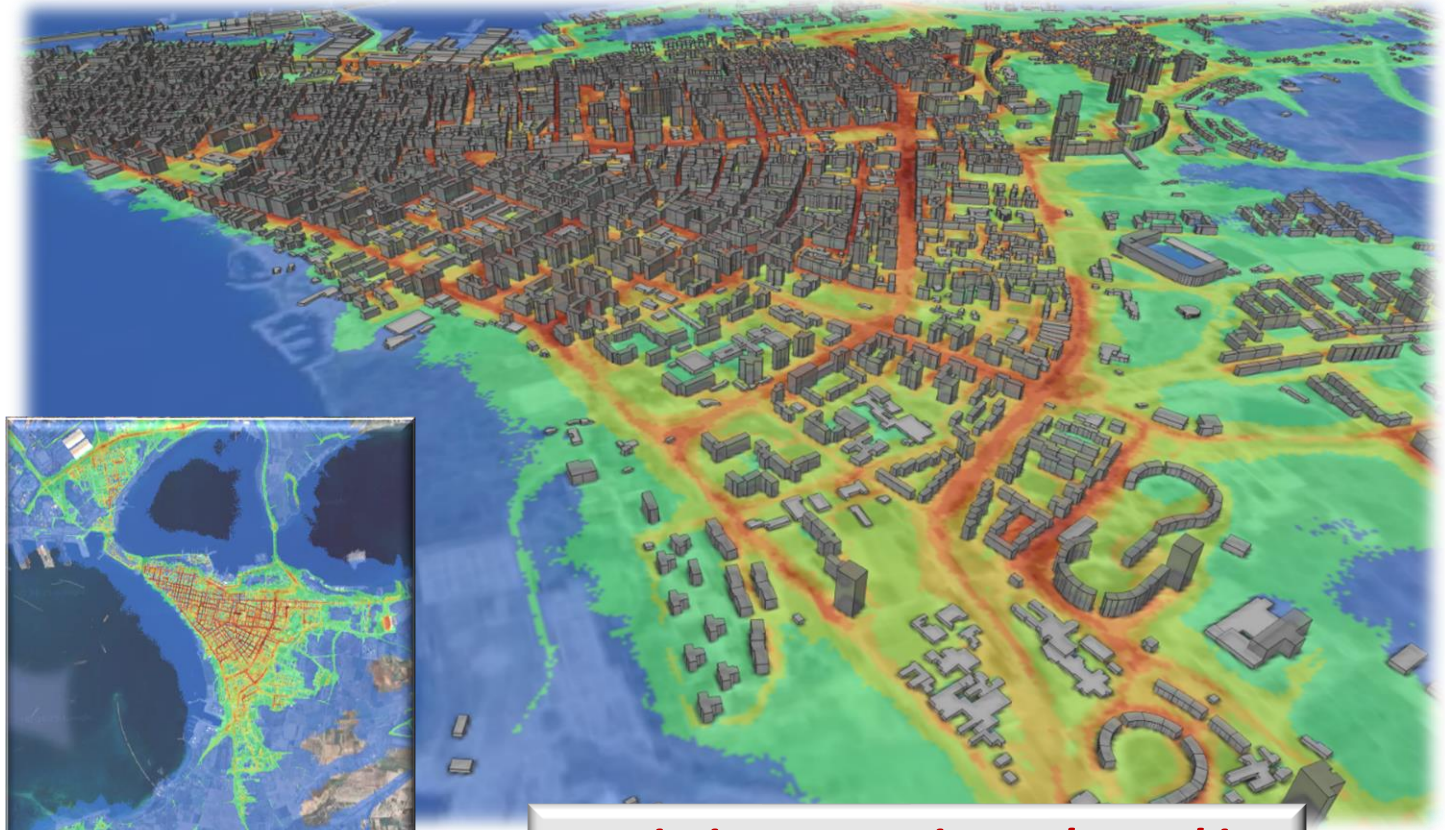
CALLIOPE: Convolution of PMSS dispersion kernels at microscale

- Methodology to compute **fast** and **efficiently** mean concentration maps
  - over a full city - domain ***100 km sq***
  - At microscale - horizontal resolution ***5 m***

- Suitable for **emission scenario** evaluations



NO2 ANNUAL MEAN FROM TRAFFIC EMI (Taranto)



How it works

- A database of dispersion kernels is built running **PMSS** (*steady-state and normalized emission*) for a set of **classified met conditions** for each source (eg road segment)

- Hour by hour, kernels are **selected from the database** for each source on the basis of the driving ***meteorology***, and rescaled according to ***emissions***

- Convolution and following time average give rise to the final concentration field.

- Regional background concentration from CTM

Emission scenario evaluated in 10 minutes

Natural based solutions modelling in an urban environment

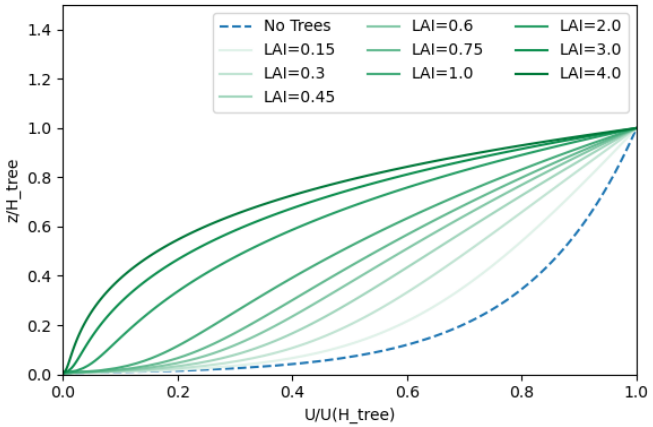
Aerodynamic effect

trees modify the wind profile, reducing the wind speed.
The net effect is an **increase of the concentration**

Dry deposition

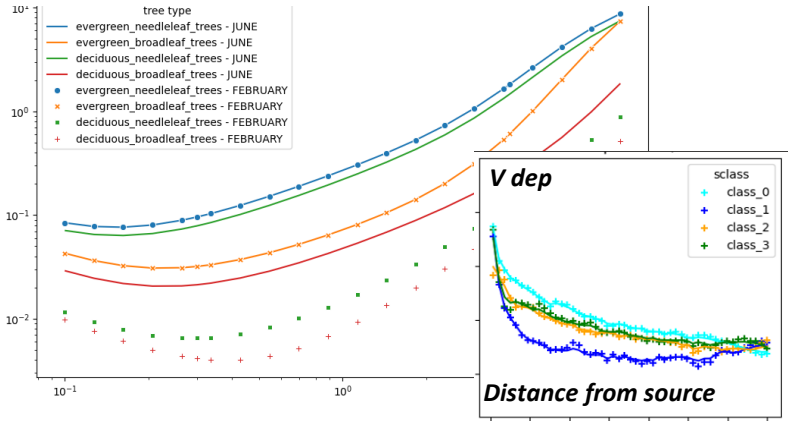
The deposition of pollutants on the leaves removes mass from the atmosphere,
reducing the concentration

Wind profile modification



Maison et al 2022; Wang 2011

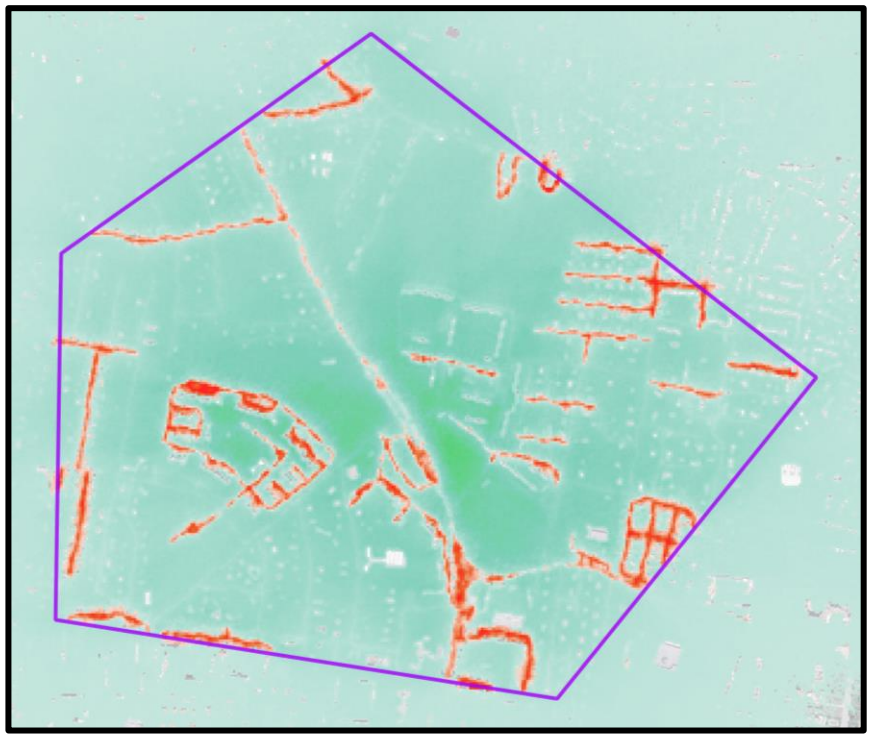
Deposition velocity VS particle size



Linden et al 2023; Petroff et al 2010; Zhang 2001, 2003

CONCENTRATION DIFFERENCE

With Natural Based Solutions
MINUS
Without Natural Based Solutions



- Both effects are parametrized with a direct dependence on **Leaf Area Index**
- Deposition is studied with **PMSS** classifying the sources on the basis of the buildings morphology around them
- The NBS effects are applied by «selection and rescaling» in the kernel convolution framework

*Outside the polygon boundary, the deposition is constant and keeping the value on the boundary.

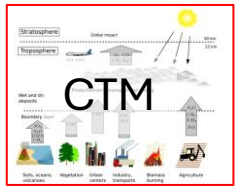
CAMs EvOlution (CAMEO) – Sentinel 5P TROPOMI assimilation

Funded by the European Union

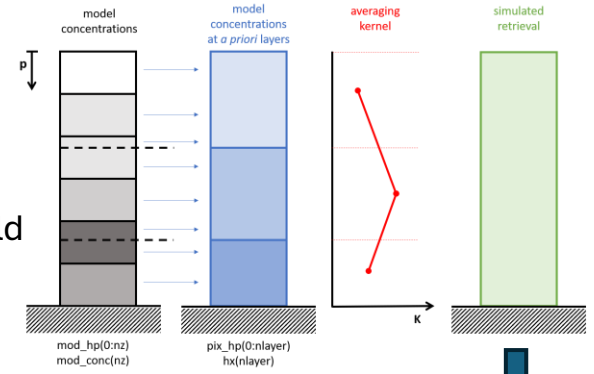
Enhancement of Satellite Data Assimilation in CAMS models

"As shown in this image acquired by one of the Copernicus Sentinel-3 satellites at 09:23 UTC of 14 August, less than 8 hours after the beginning of the eruption, the ash reached the centre of the Mediterranean Sea and travelled 300 km southeast of Malta"

Credit: European Union, Copernicus Sentinel-3 imagery



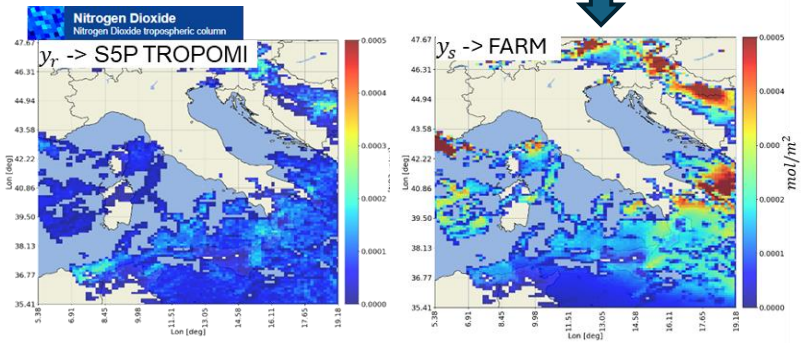
3D field



vcd

TROPOMI – S5P

Sp. res:
$5.5\ x\ 3.5\ km^2$
$(\boldsymbol{NO_2}, \boldsymbol{SO_2}, \boldsymbol{HCHO})$



$$x_i^a = x_i^f + K_i\left(y^o - H_i x_i^f\right)$$

Main challenges EO data:

- Sparse data
- Noisy
- Vertical locations not defined

Ensemble Adjustment Kalman Filter

DART

MINNI + DART

"The CAMEO project (grant agreement No101082125) is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Commission. Neither the European Union nor the granting authority can be held responsible for them."

Ensemble Data Assimilation – Earth Observations

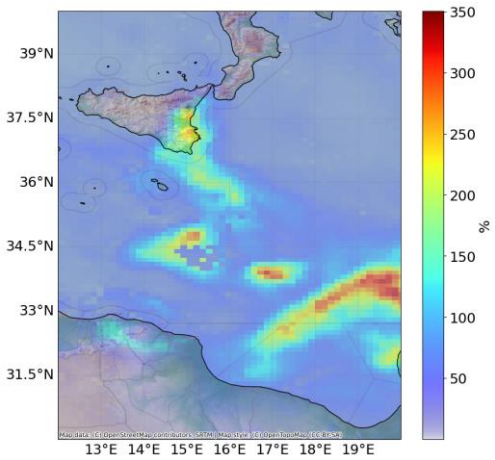
EGU General Assembly 2025

Session AS3.33

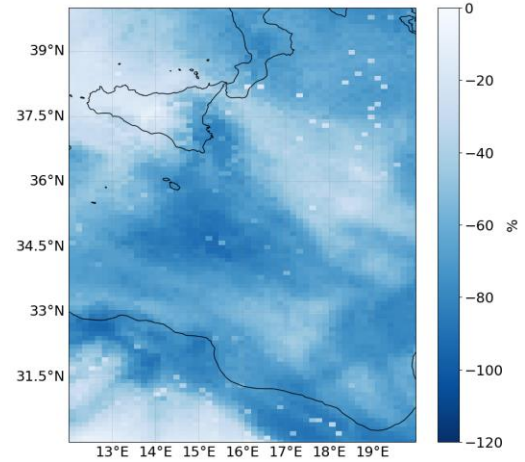
The study examines the use of Data Assimilation (DA) by incorporating sulfur dioxide (SO_2) column data from the Sentinel-5p L2 COBRA retrieval (5.5 km x 3.5 km resolution and 2660 km swath) in MINNI (0.15° x 0.1°, 14 vertical levels), a model member of the CAMS regional air quality ensemble and based on the Chemical Transport Model (CTM) FARM [2]

	Description
DA Method	Ensemble Adjustment Kalman Filter (EnAKF) via DART
Coupled Model	MINNI + DART
Ensemble Setup	20 members, hourly assimilation window
Perturbations	Emissions & boundary conditions
Forward Operator	Copernicus Satellite Operator (CSO), uses averaging kernels
Localization	Vertical, 5th-order Gaspari-Cohn function
Inflation	Applied to reduce filter divergence
QC Filter Method	Quantile Conserving Ensemble Filter Framework

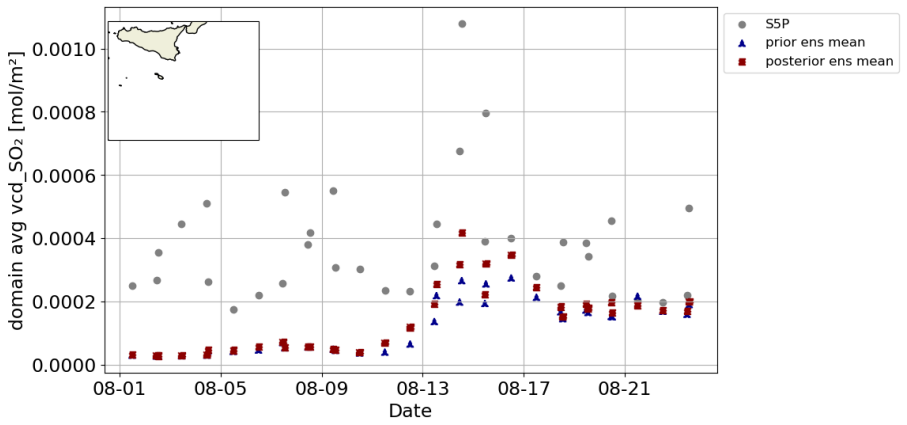
August 1 to August 20, 2023

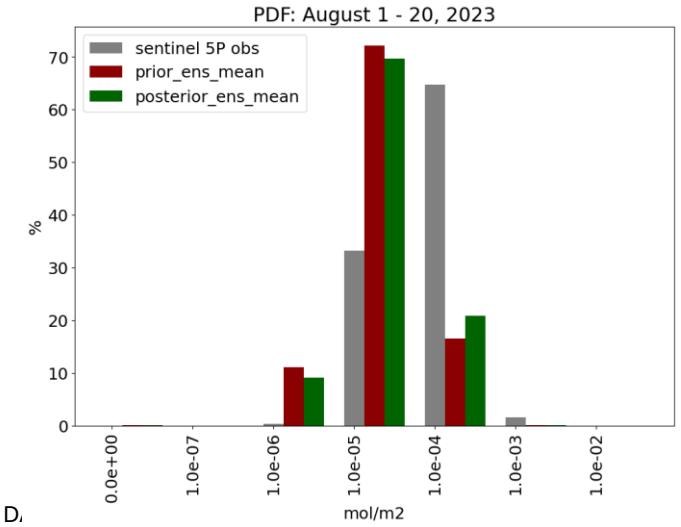


RMS of relative increments (posterior state minus prior state divided by prior state)



posterior spread minus prior spread divided by prior spread)





[2] D'Ausilio, A., De Moliner, G., Silibello, C., Bolignano, A., Briganti, G., Russo, F., and Mircea, M.: Assessing the impacts of assimilating SO2 TROPOMI retrievals with MINNI and D. the Mount Etna eruption, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-16042, https://doi.org/10.5194/egusphere-egu25-16042, 2025.

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Thank you for your attention!

Greetings from Milan

s.finardi@aria-net.it