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CAMS – FAIRMODE WG8 *Natural Dust* – Joint evaluation exercise: Contribution from ITALY

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Atmosphere Monitoring

7th CAMS Policy User Workshop, 4-10-2023, Athens

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The Context

- Exceedances of the daily limit values (DLV) of particulate matter (PM) set by the European Ambient Air Quality Directive can be considered not as such if it can be 'proven' that these are caused by particles of natural origin.

- Specific **Guidelines** were released by the European Commission in **2011** suggesting methodologies to perform such an assessment for different 'natural' particle types, including desert dust.

- In Italy the National Institute for Environmental Protection and Research (ISPRA) set up a tool to apply the EC-Guidelines Methodology

- In parallel, in the framework of an EC-Life+ Project (DIAPASON), the Institute of Atmospheric Science and Climate (CNR-ISAC) developed a further **automatic tool**, building on the EC-Guidelines-Methodology and addressing some limits encountered in the Guidelines operational application.

DIAPASON Methodology (ITALY) by CNR-ISAC
Barnaba et al., Atm. Env., 2017
Barnaba et al., Env. Int., 2022

Life DIAPASON
Desert-dust Impact on Air quality through model-Predictions and Advanced Sensors ObservatioNs
LIFE+10 ENV/IT/391

- In the framework of an EC-ERA4CS Project (DustClim) the DIAPASON approach was applied at EU Scale

Barnaba et al., in prep. 2023

DustClim ERA4CS European Research Area for Climate Services

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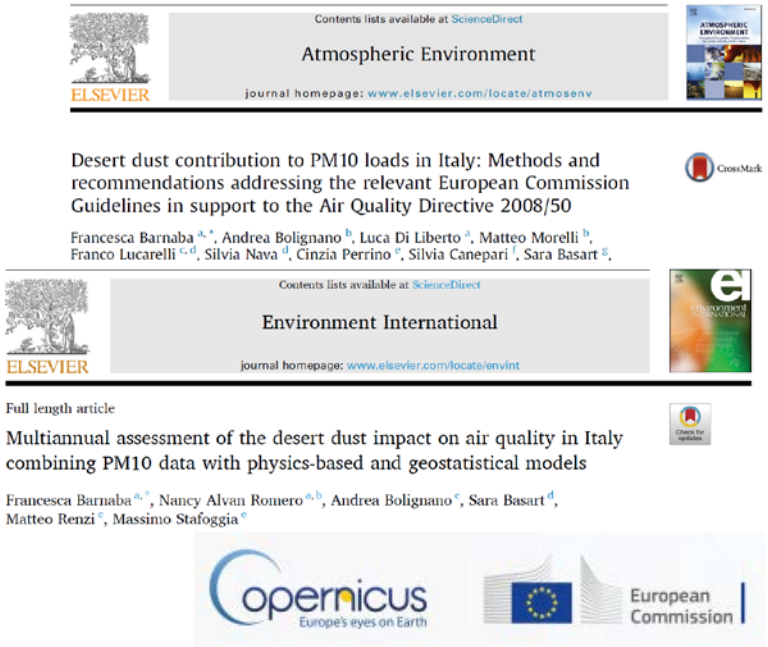
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Desert dust contribution to PM10 loads in Italy: Methods and recommendations addressing the relevant European Commission Guidelines in support to the Air Quality Directive 2008/50

Francesca Barnaba [a,*], Andrea Bolignano [b], Luca Di Liberto [a], Matteo Morelli [b], Franco Lucarelli [c,d], Silvia Nava [d], Cinzia Perrino [e], Silvia Canepari [f], Sara Basart [g],

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Full length article

Multiannual assessment of the desert dust impact on air quality in Italy combining PM10 data with physics-based and geostatistical models

Francesca Barnaba [a,*], Nancy Alvan Romero [a,b], Andrea Bolignano [c], Sara Basart [d], Matteo Renzi [c], Massimo Stafoggia [e]

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The FAIRMODE WG8 Natural dust Excercise

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- Before the summer, we participated in the CAMS – FAIRMODE **WG8 Joint evaluation exercise** on the evaluation of Natural Dust contribution to exceedances of limit values

- It was agreed to focus this exercise on some specific desert dust transport episodes in 2022

- This presentation shows results of this first exercise and puts the relevant results in a future perspective

Requested info:

1) timeframe of the exceedance to be analysed: June 2022 Episode & whole test year 2022

2) main reason why this episode is selected: Just as show case (high dust load, but similar cases observed in 2022)

3) Currently used deduction methodology (short)- Name and reference to guidance documents: DIAPASON Methodology (*Barnaba et al., 2017, 2022, 2023)*.

4) Testing CAMS dust products – list here what products you chose to use for deduction of dust contribution to exceedances.

CAMS2_40_OBS_PM10_E2a_2022_ug.m3_v20230418
CAMS2_40_OBS_PM10_E2aDailyMean_ug.m3_v20230509
CAMS2_40_REG_ENS_IRA2022_DUST_E2a_ug.m3_v20230418

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Natural Dust contribution – Current method

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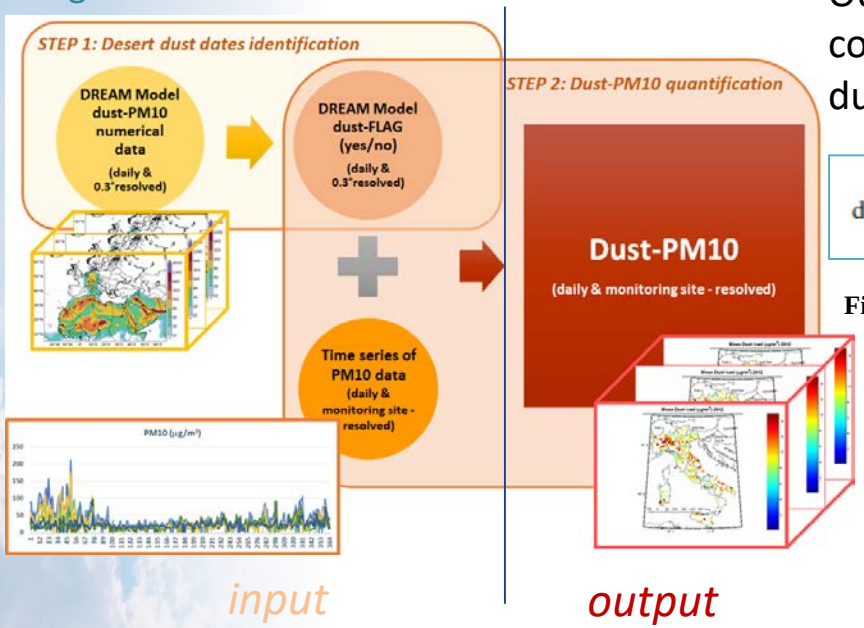
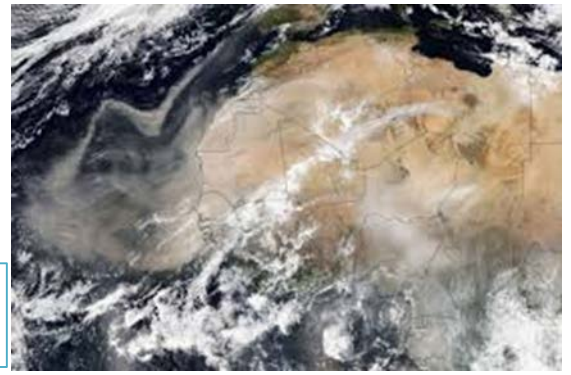
Explain the dust deduction methodology currently used: DIAPASON



Our method is a modification of the EC-Methodology combining **modelled** dust-PM10 fields (only to flag dust presence) and **PM10 measurements**

$$\text{dust-PM10}_{MS}(\text{dust day}) = \Delta PM10 = PM10_{MS}(\text{dust day}) - \langle PM10_{MS}(\text{out-of-dust}) \rangle$$



First difference: run over ALL sites, not only over RB sites

Third difference: fully automatic, no supervision needed

The second is that the out-of-dust reference value is computed using the 50th percentile over a shorter temporal window of ±3 days from the dust-affected dates.

In our original methodology, we used the **BSC Dream8bV2** (no more available)

*For this exercise we used the **BSC NMMB model***

***Acknowledgement: NMMB data were provided by** the WMO Barcelona Dust Regional Center and the partners of the Sand and Dust Storm Warning Advisory and Assessment System **(SDS-WAS)** for Northern Africa, the Middle East and Europe.*

IMPORTANT:

1) **We use <u>daily average</u> PM10 values** (modelled and measured), **as this is the metric currently legislated by EC**
2) **What do we obtain<u>: daily and site resolved dust-PM10</u>**

For the requested exercise we also run the methodology using CAMS

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SPECIFIC EPISODE: Rome, end of June 2022

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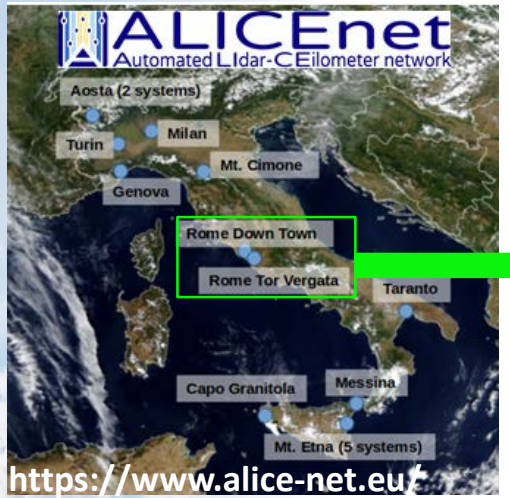
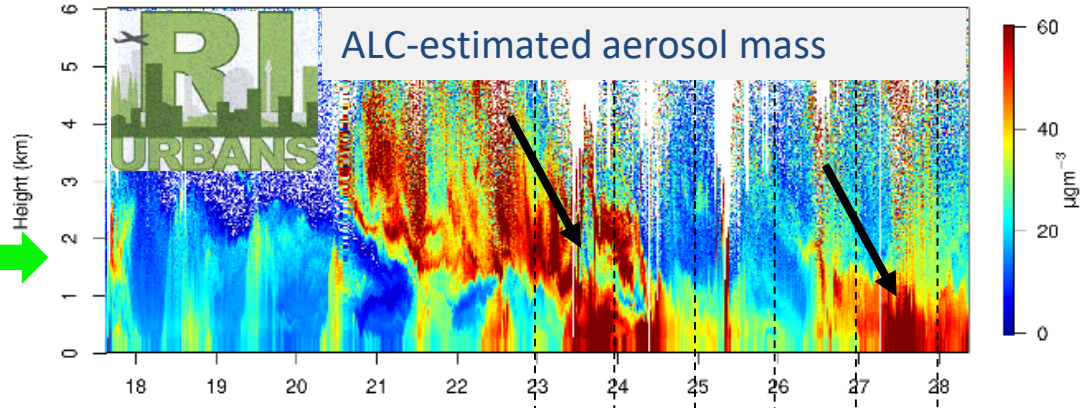
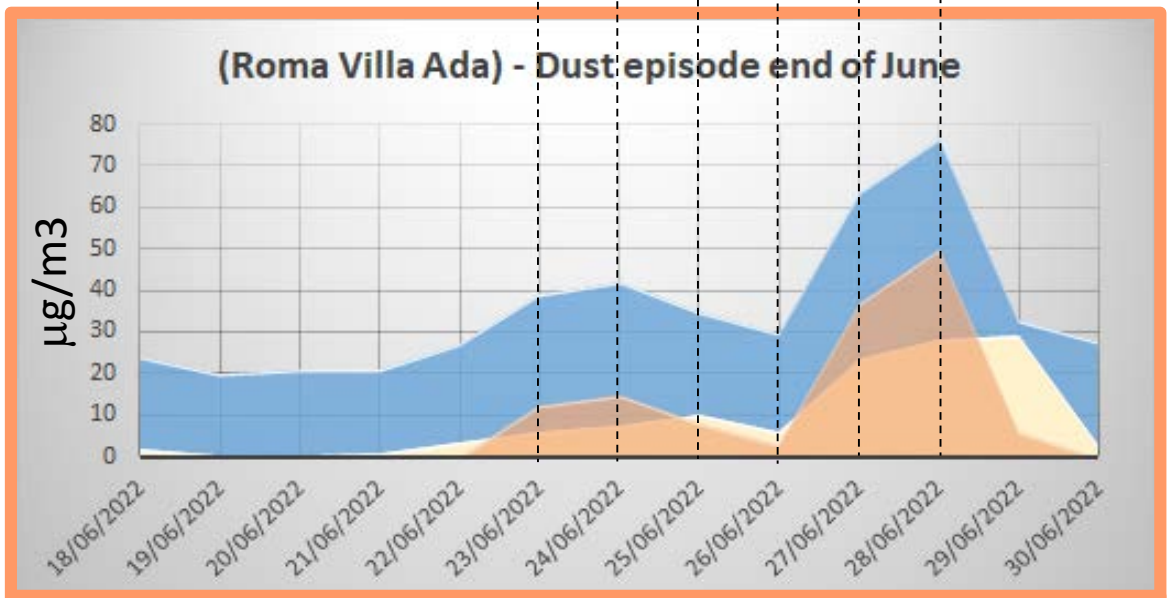
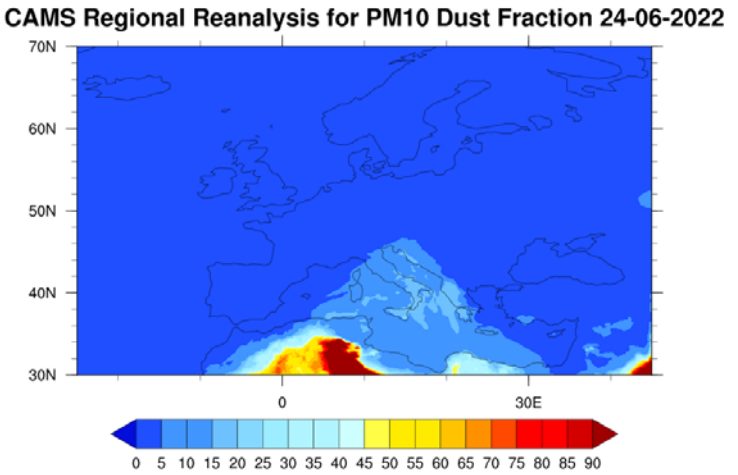
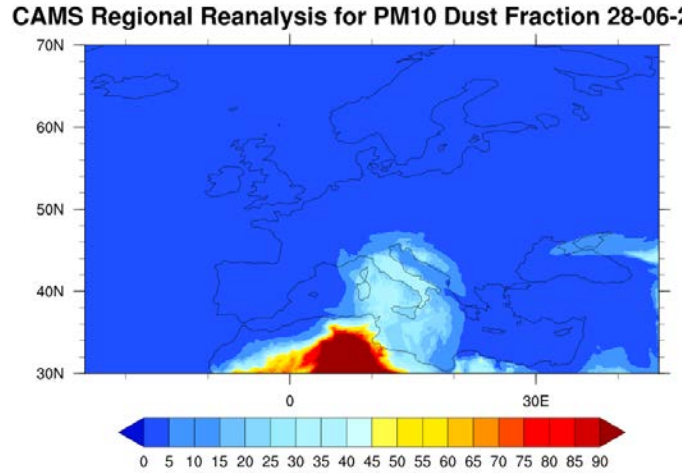






Measured PM10
CAMS dust-PM10
Estimated dust-PM10 (our Method with CAMS Flag)





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Natural Dust contribution - current & CAMS

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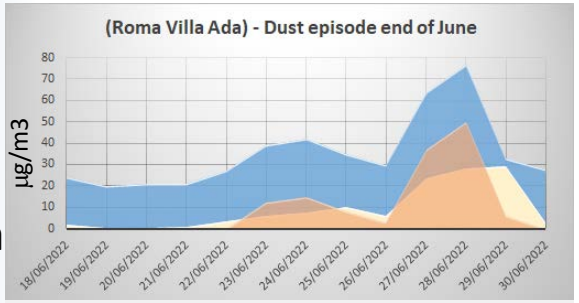
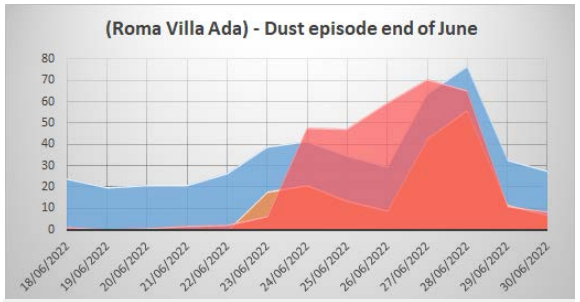
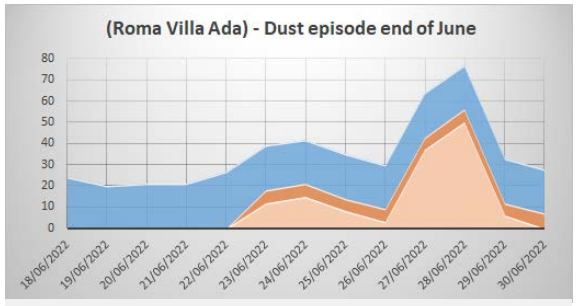
Site:
Rome Villa Ada



Measured PM10
CAMS dust-PM10
Estimated dust-PM10 (our Method with CAMS Flag)



Measured PM10
NMMB dust-PM10
Estimated dust-PM10 (our Method with NMMB Flag)



Measured PM10
Estimated dust-PM10 (our method with NMMB Flag)
Estimated dust-PM10 (our Method with CAMS Flag)

Dates	PM10 value before correction	Calculated PM10 dust contribution – «Current method»	Calculated PM10 dust contribution – «CAMS based method»	PM10 value after deduction of dust contribution – «Current method»	PM10 value after deduction of dust contribution – «CAMS based method»
27-6-22	64 (PM10 exceedance)	43	37	21 (no exceedance)	27 (no exceedance)
28-6-22	77 (PM10 exceedance)	56	50	21 (no exceedance)	27 (no exceedance)

This kind of info has been derived for each day 2022 and for each monitoring site in EU !!!

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Just few days before in Paris (11-19/06/2022)

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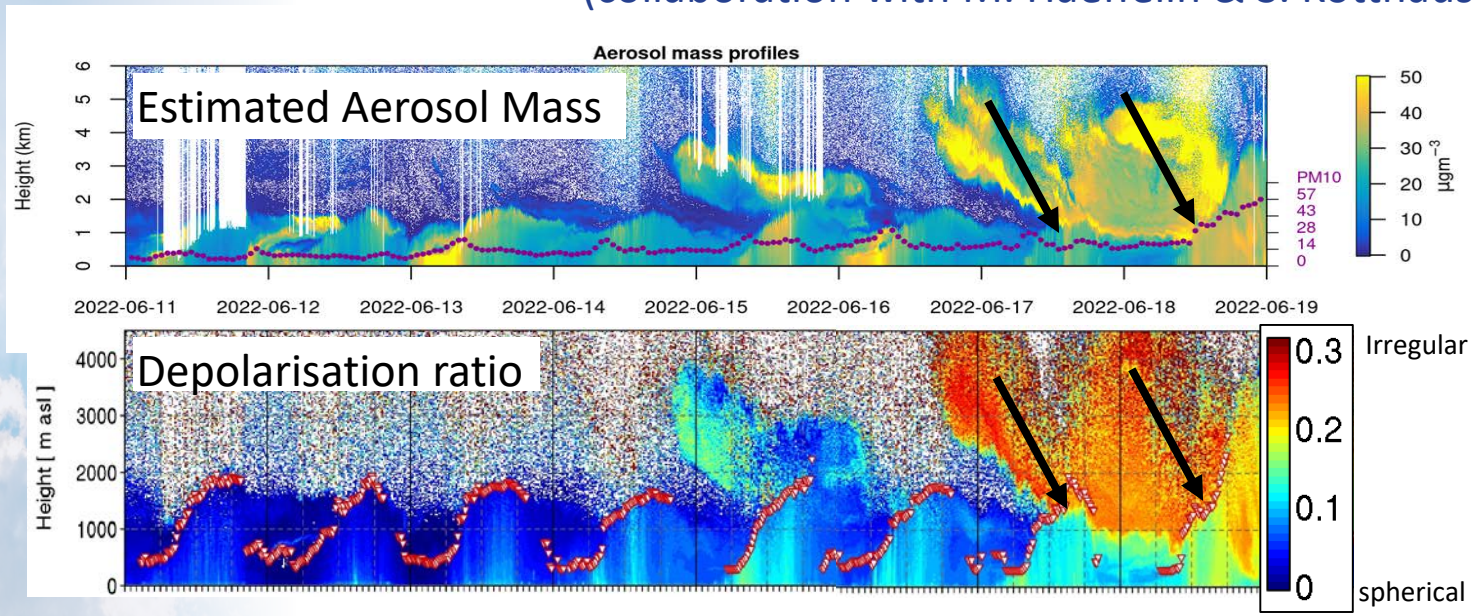
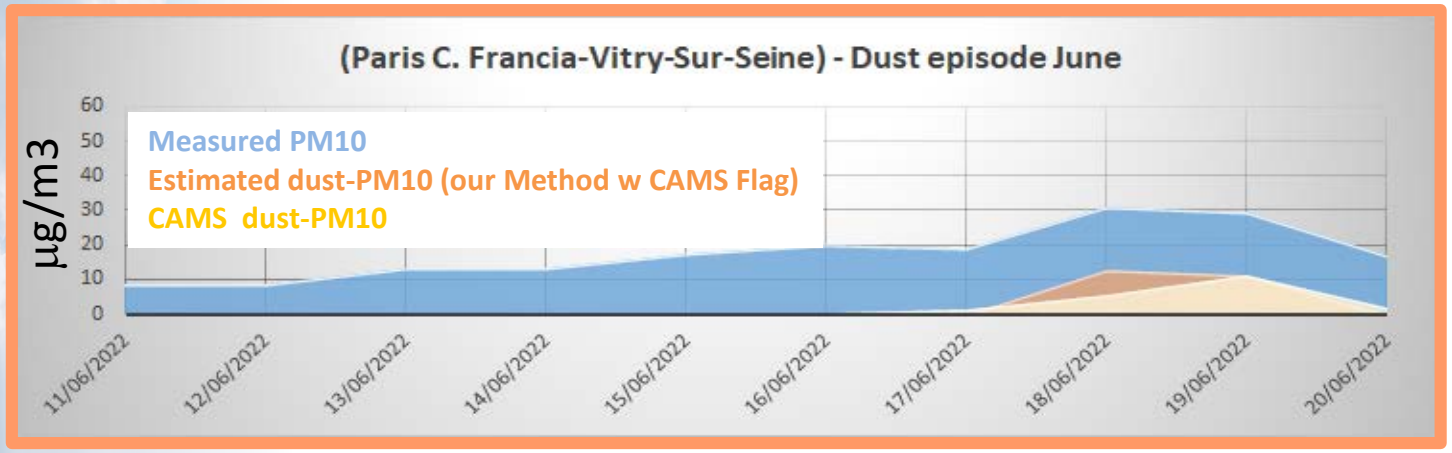
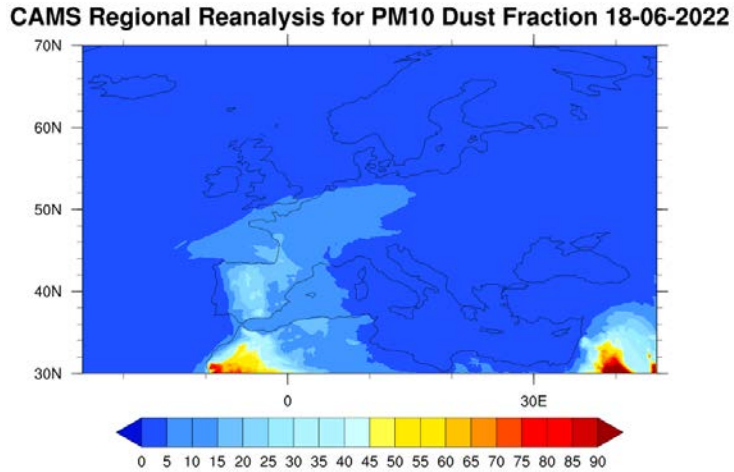
ALICEnet Automated Lidar-CEilometer network

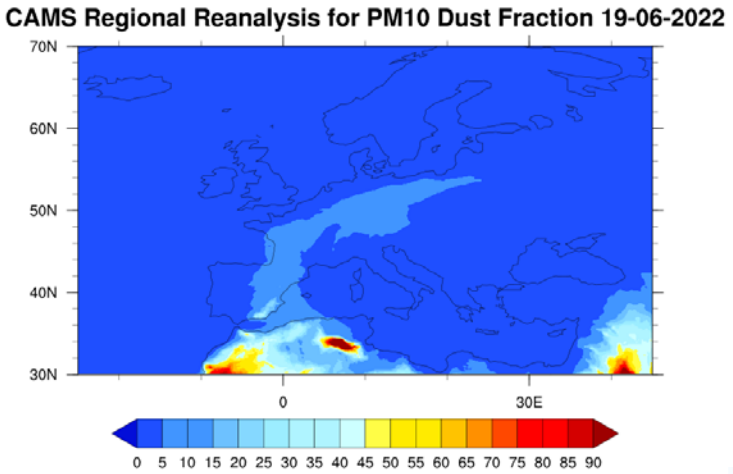
Aerosol mass retrievals applied to **Paris** ALC data
(collaboration with M. Haeffelin & S. Kotthaus, IPSL, Paris)

PANAME RI URBANS PROBE COST ACTION









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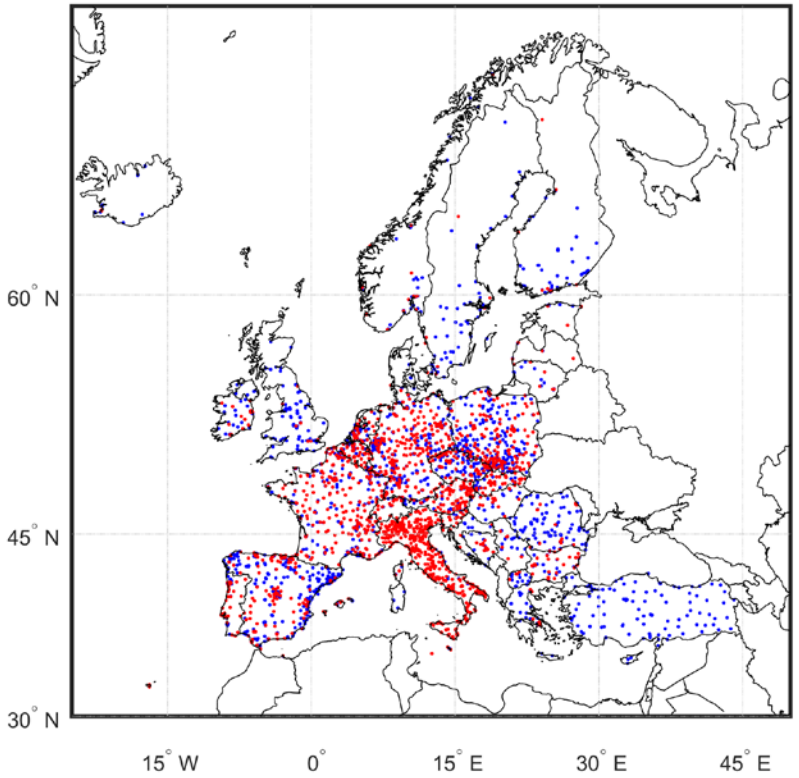
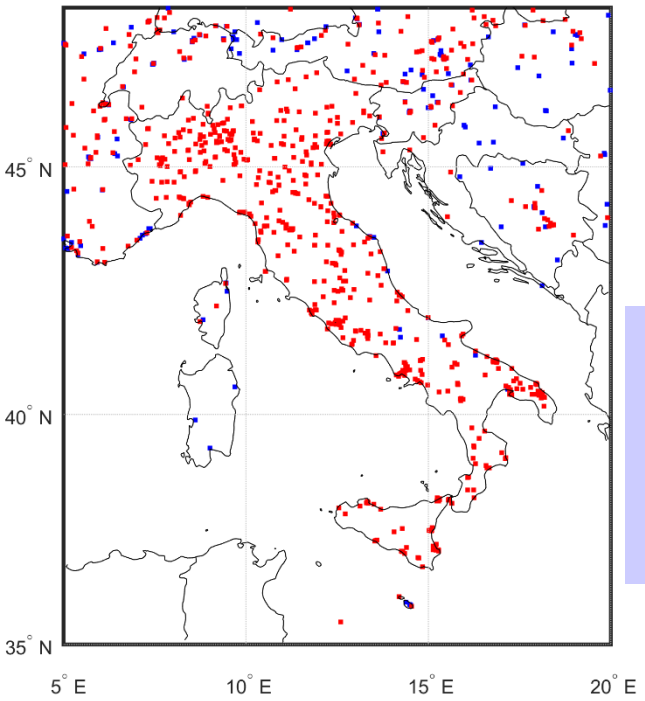
Enlarging the picture

CAMS2_40_OBS_PM10_E2a_2022_ug.m3_v20230418
CAMS2_40_OBS_PM10_E2aDailyMean_ug.m3_v20230509



Drawback: several missing data (in blue);
Due to this problem, over Italy we used the (ISPRA) national database
(which was however still partially incomplete for 2022, e.g. Sardinia)



4102 listed stations with hourly res. data
+
207 Listed stations with daily res. data

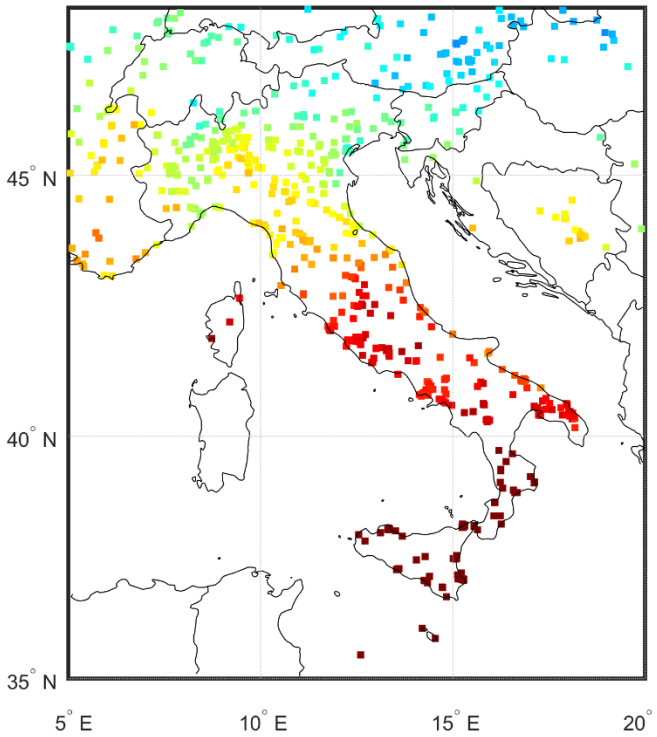
End up with 1743 sites in EU with valid data (red)

EEA dataset Italy; out of > 650 stations in metadata
< 10 sites with hourly data (in E2a hourly mean file)
< 200 with daily data (in E2a daily mean file)

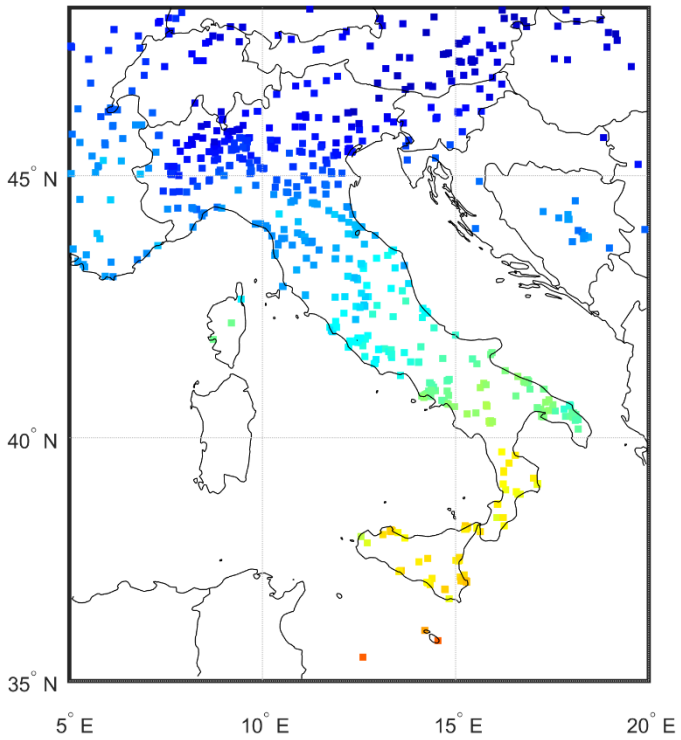
→We added 500 stations from our national database

Test results over Italy, whole 2022 (1)

Year 2022
DIAPASON fed by NMMB

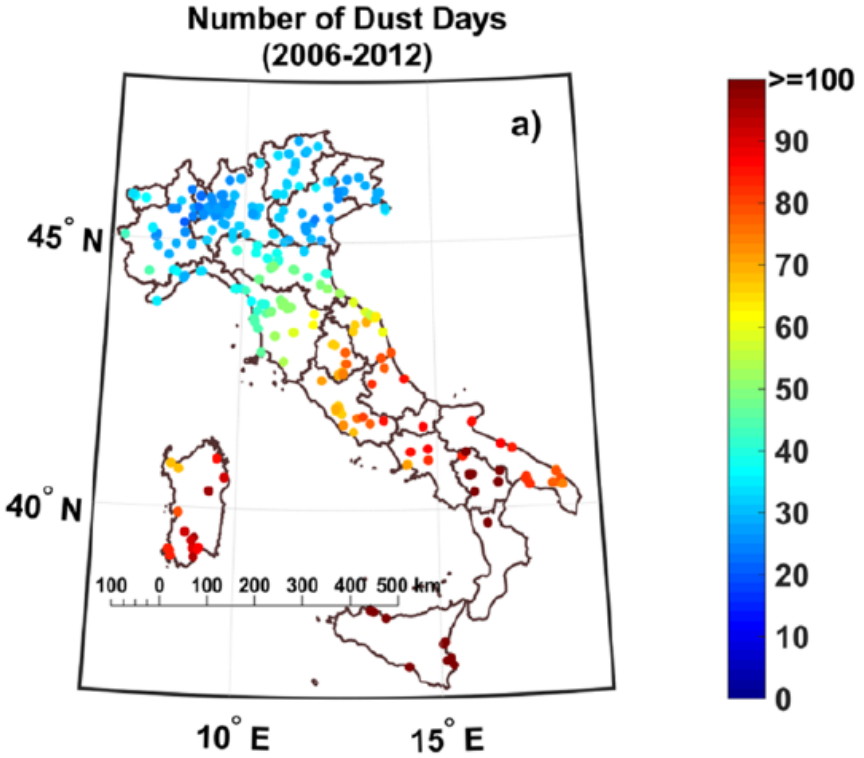


Year 2022
DIAPASON fed by CAMS



Number of Dust-Days

Comparison to previous statistics

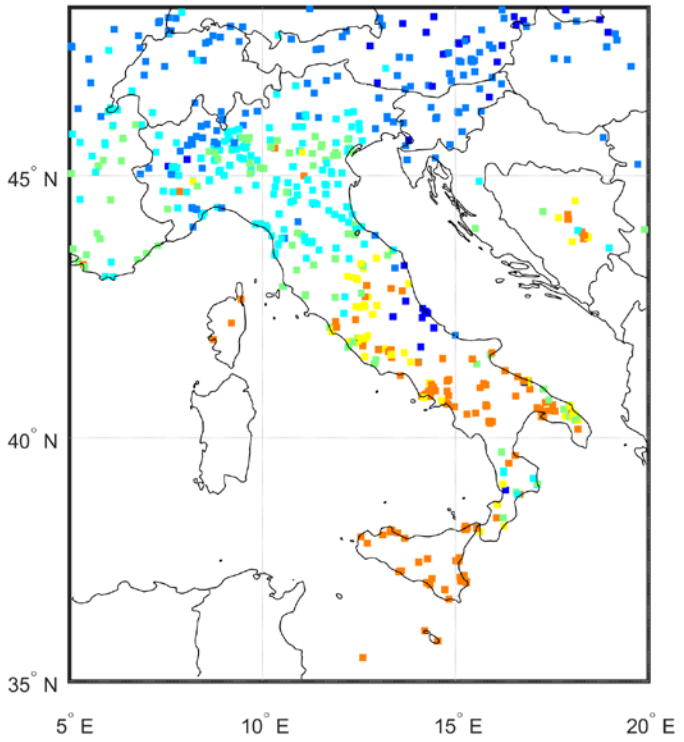


Barnaba et al., Env. Int. 2022

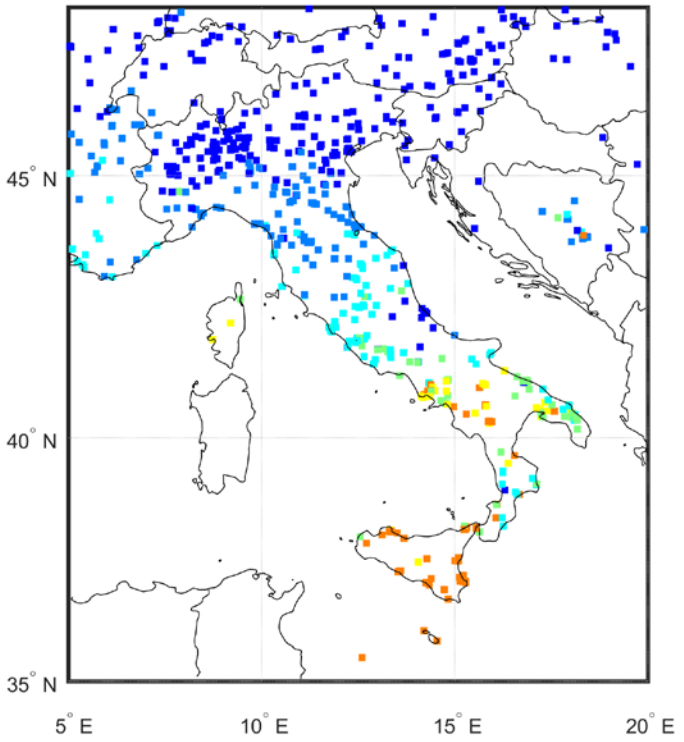
Test results over Italy, whole 2022 (2)

Dust impact on Yearly average PM10

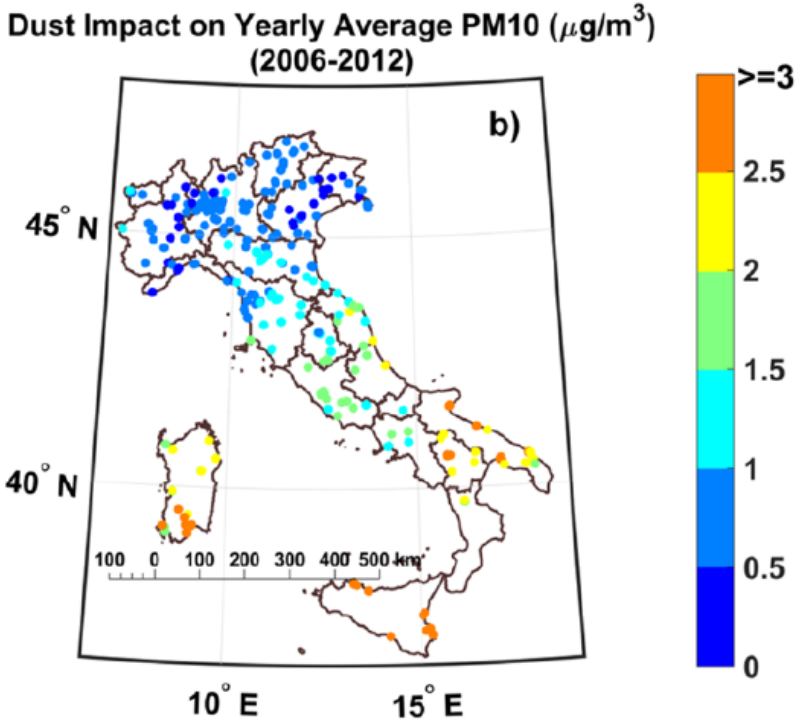
Year 2022
DIAPASON fed by NMMB



Year 2022
DIAPASON fed by CAMS



Comparison to previous statistics

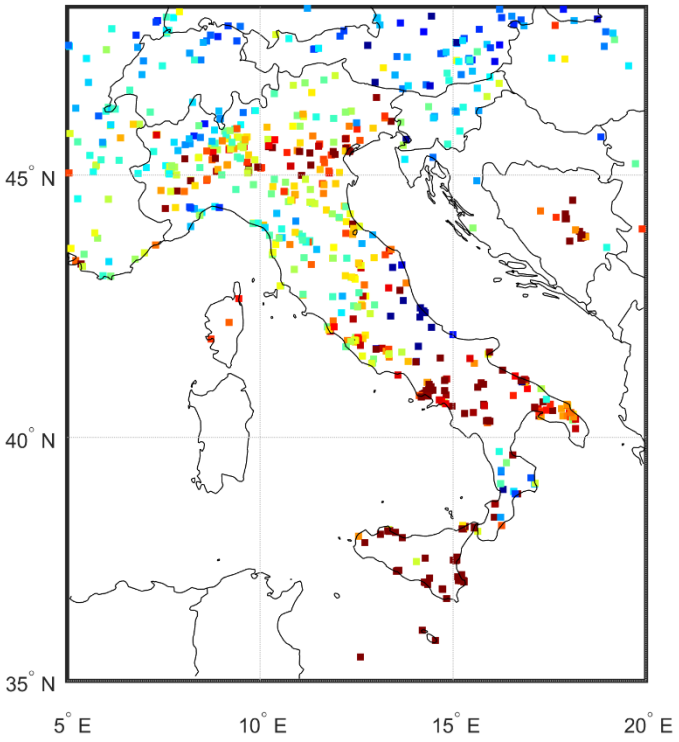


Barnaba et al., Env. Int. 2022

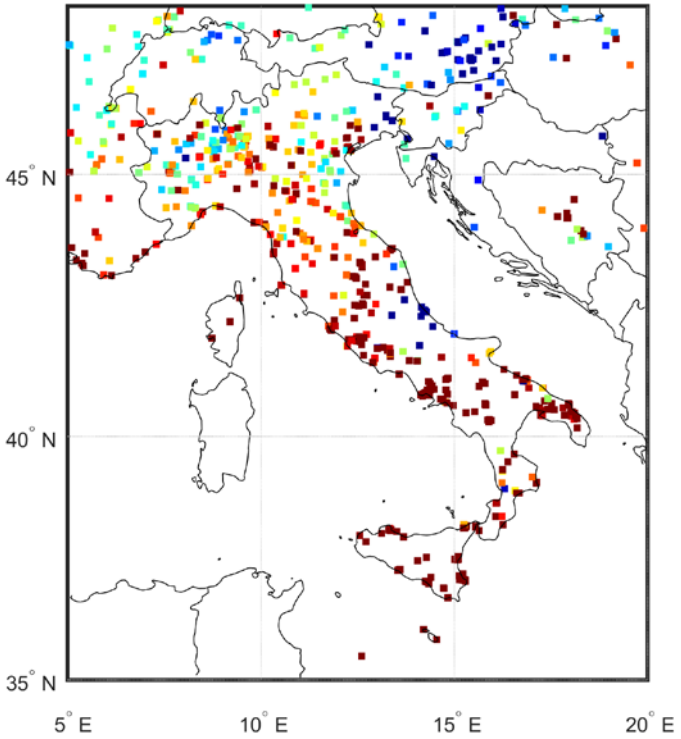
Test results over Italy, whole 2022 (3)

Dust-PM10 per dust day

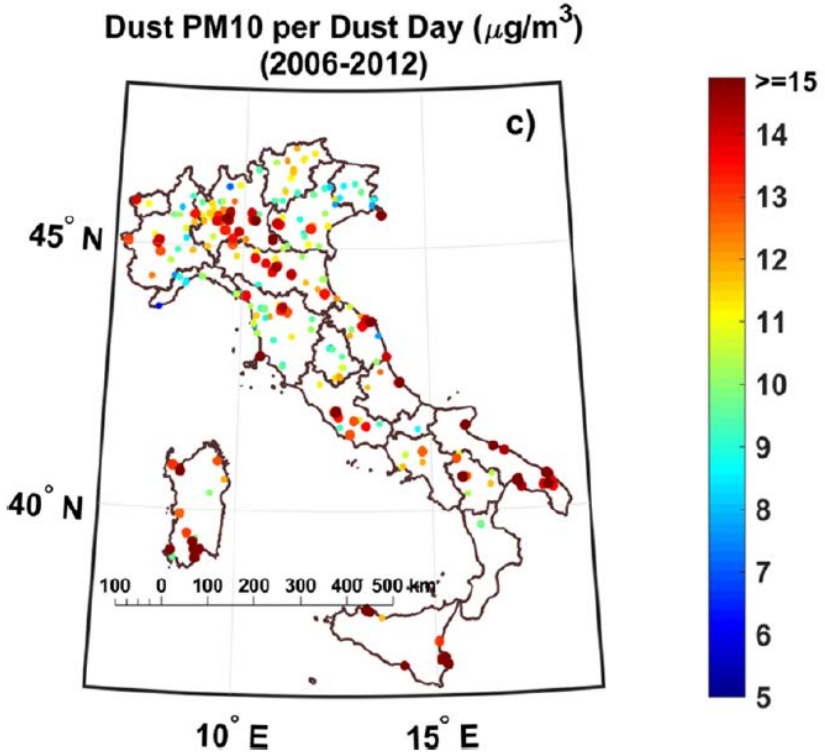
Year 2022
DIAPASON fed by NMMB



Year 2022
DIAPASON fed by CAMS



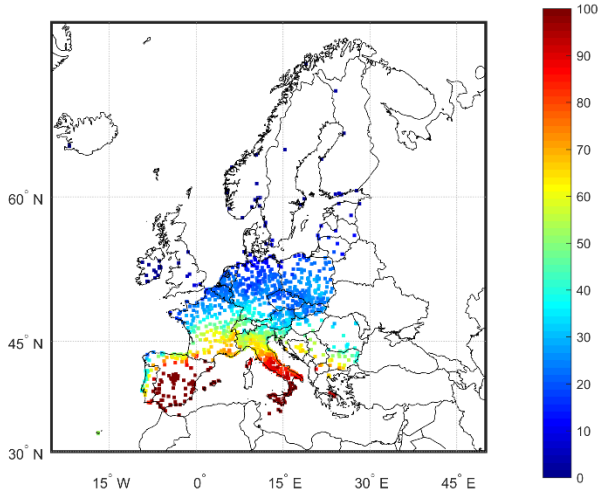
Comparison to previous statistics



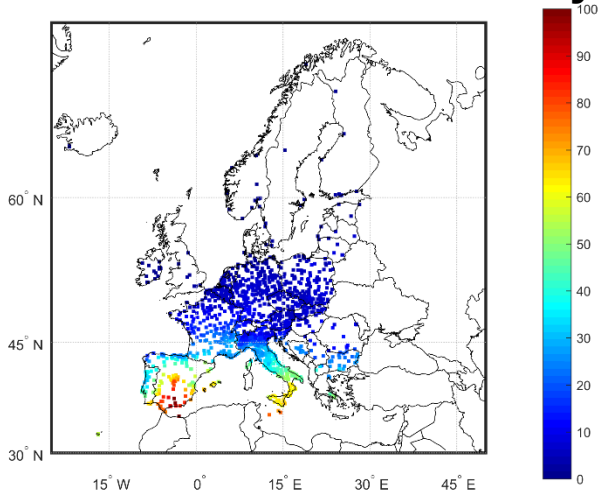
Barnaba et al., Env. Int. 2022

Test results over EU, whole 2022 (1)

Year 2022 DIAPASON fed by NMMB



Year 2022 DIAPASON fed by CAMS



Note: not directly comparable - different color scale!

Number of Dust-Days

Comparison to previous statistics

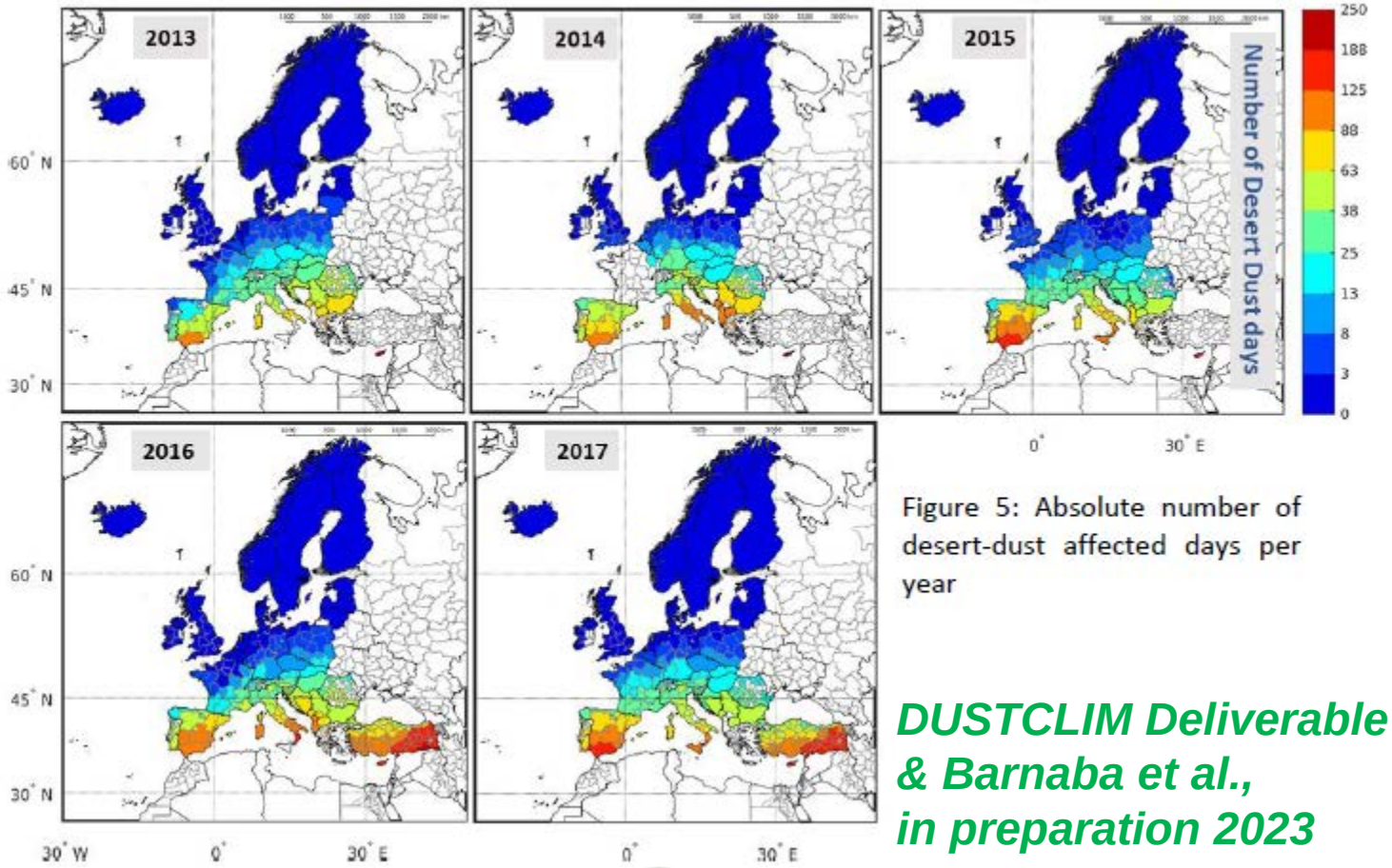


Figure 5: Absolute number of desert-dust affected days per year

DUSTCLIM Deliverable & Barnaba et al., in preparation 2023

Results over EU, whole 2022 (2)

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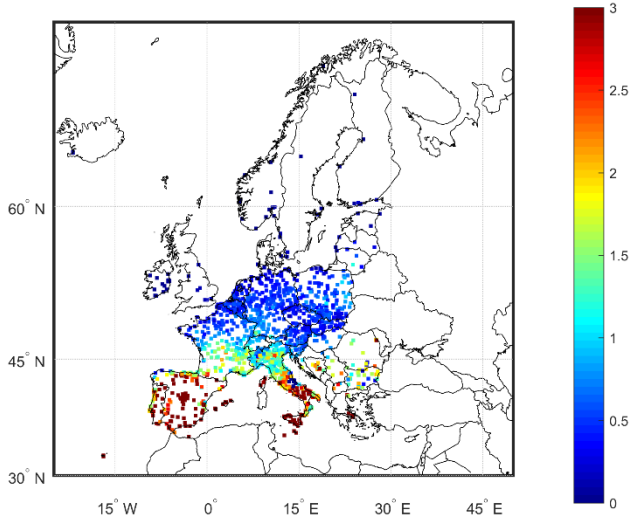
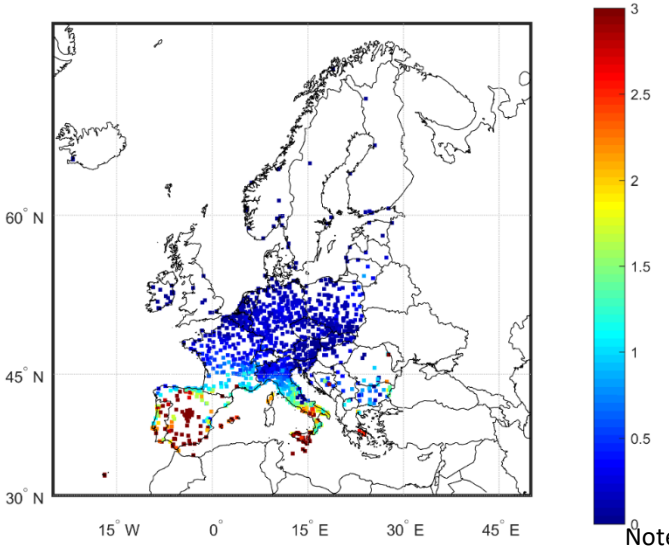
Year 2022 DIAPASON fed by NMMB



Year 2022 DIAPASON fed by CAMS



Note: not directly comparable - different color scale!

Dust impact on Yearly average PM10

Comparison to previous statistics

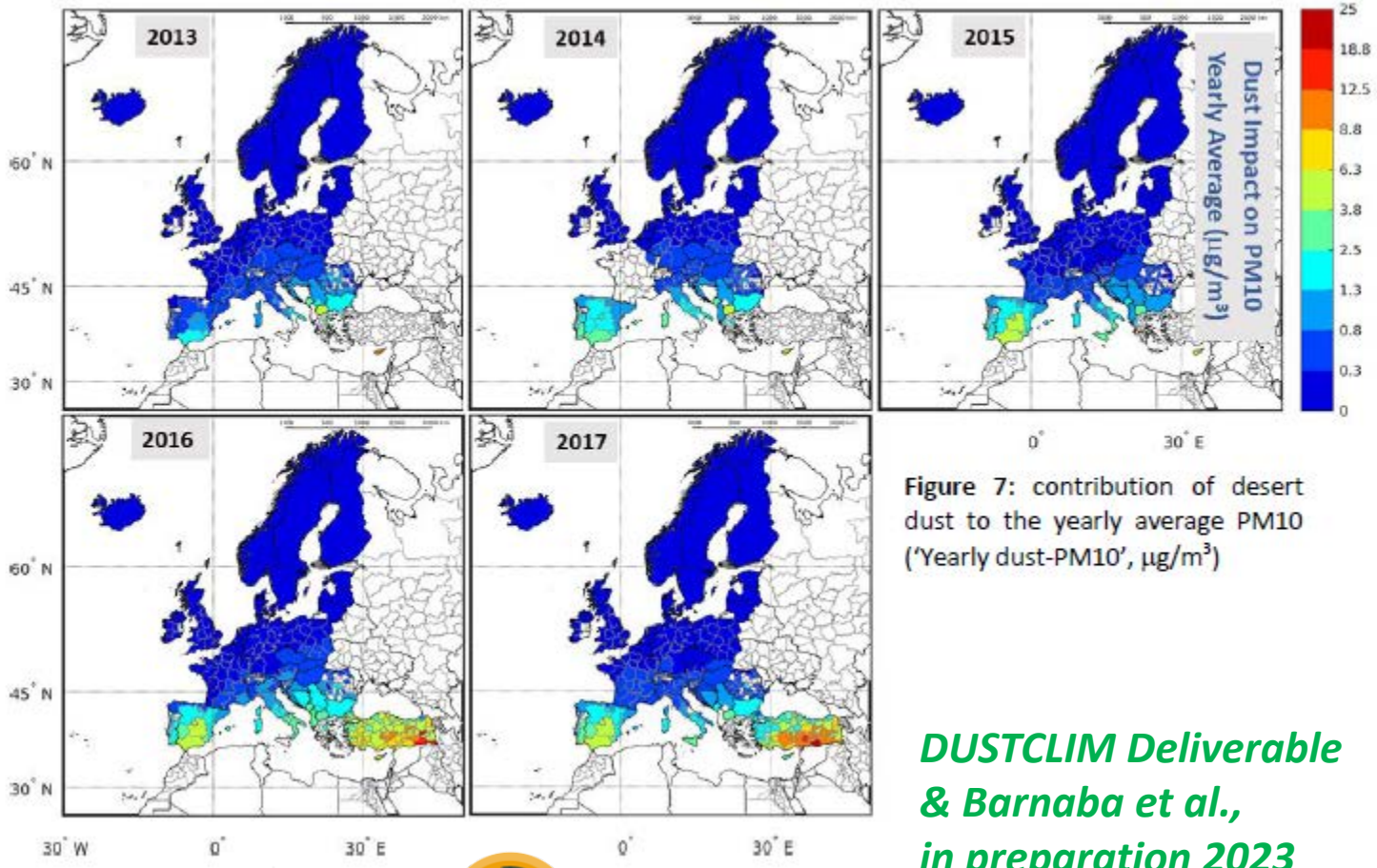


Figure 7: contribution of desert dust to the yearly average PM10 ('Yearly dust-PM10', µg/m³)

DUSTCLIM Deliverable & Barnaba et al., in preparation 2023

DustClim

ERA4CS European Research Area for Climate Services

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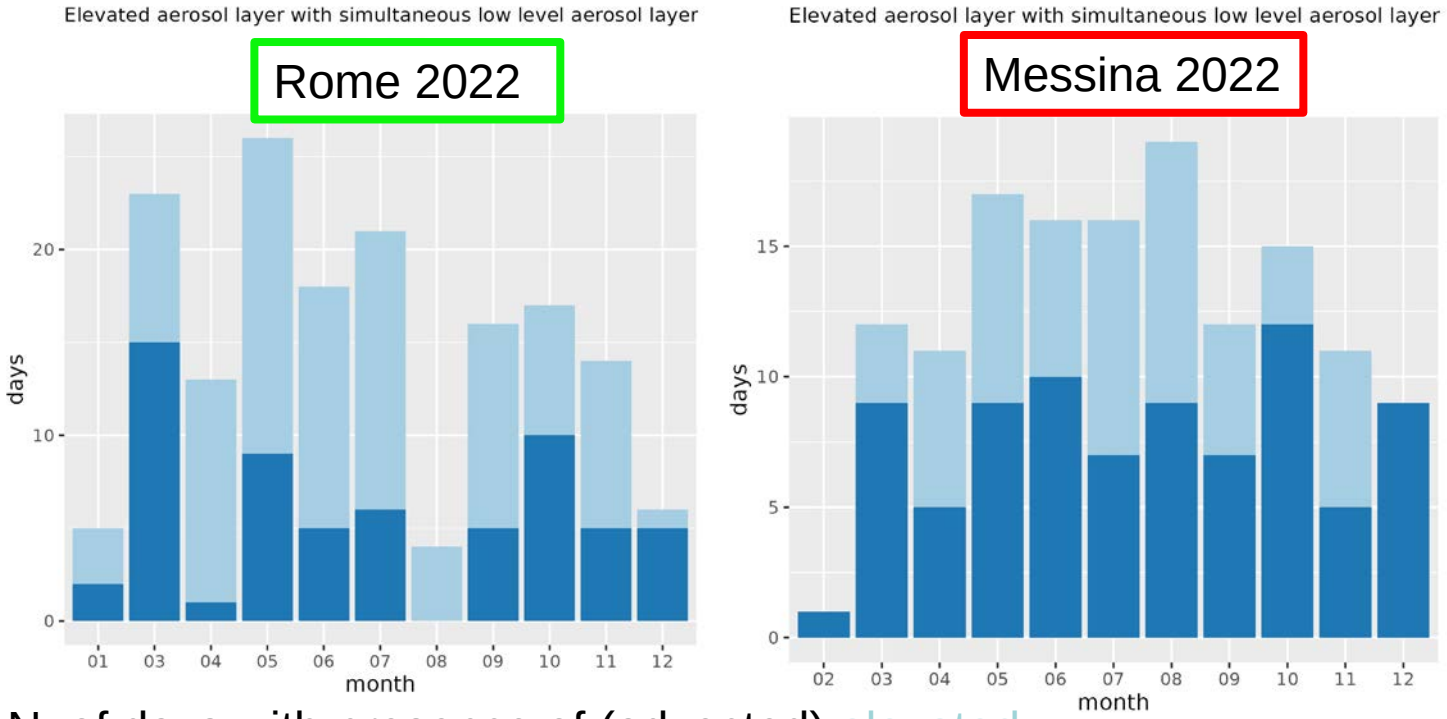
ALICEnet
Automated LIdar-CEilometer network

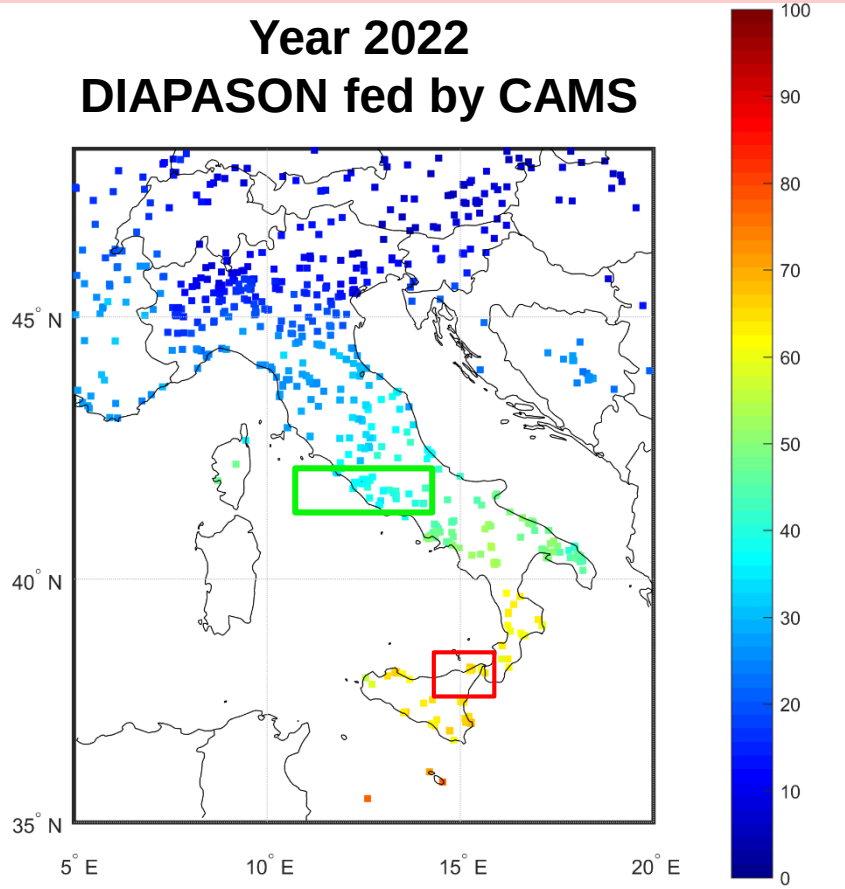
ALC based statistics



N. of days with presence of (advected) elevated layers of which with high loads in the PBL

- Roma 2022: 52
- Messina 2022: 83

Number of Dust-Days



The current threshold value (5 µg/m3) used to flag a dust-date with the model is too high for CAMS and thus needs to be 'tuned' within our methodology

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Lessons learned and next steps

Main lessons learned during these first steps

- Lesson learnt 1: CAMS (Reanalysis) seems to 'well' reproduce dust-PM10
- Lesson learnt 2: the current threshold of 5μg/m3 we used to flag dust presence with other models within our Methodology is too high for CAMS, and should be 'tuned' properly.

How do you plan to proceed for the next steps

- Several steps could be done and refinements/improvements made to our method, but this requires efforts (a proper framework, funding ..)

First examples are (shorter term)

- Test use of CAMS forecasts rather than reanalysis (if to be run in 'operational mode')
- Tune the CAMS model threshold to flag dust events (necessary for both CAMC FC and IRA, possibly the same, but to be checked); synergy with ground based remote sensing possible (e.g. ALICENET in ITALY) to perform this 'tuning'

Thank you!

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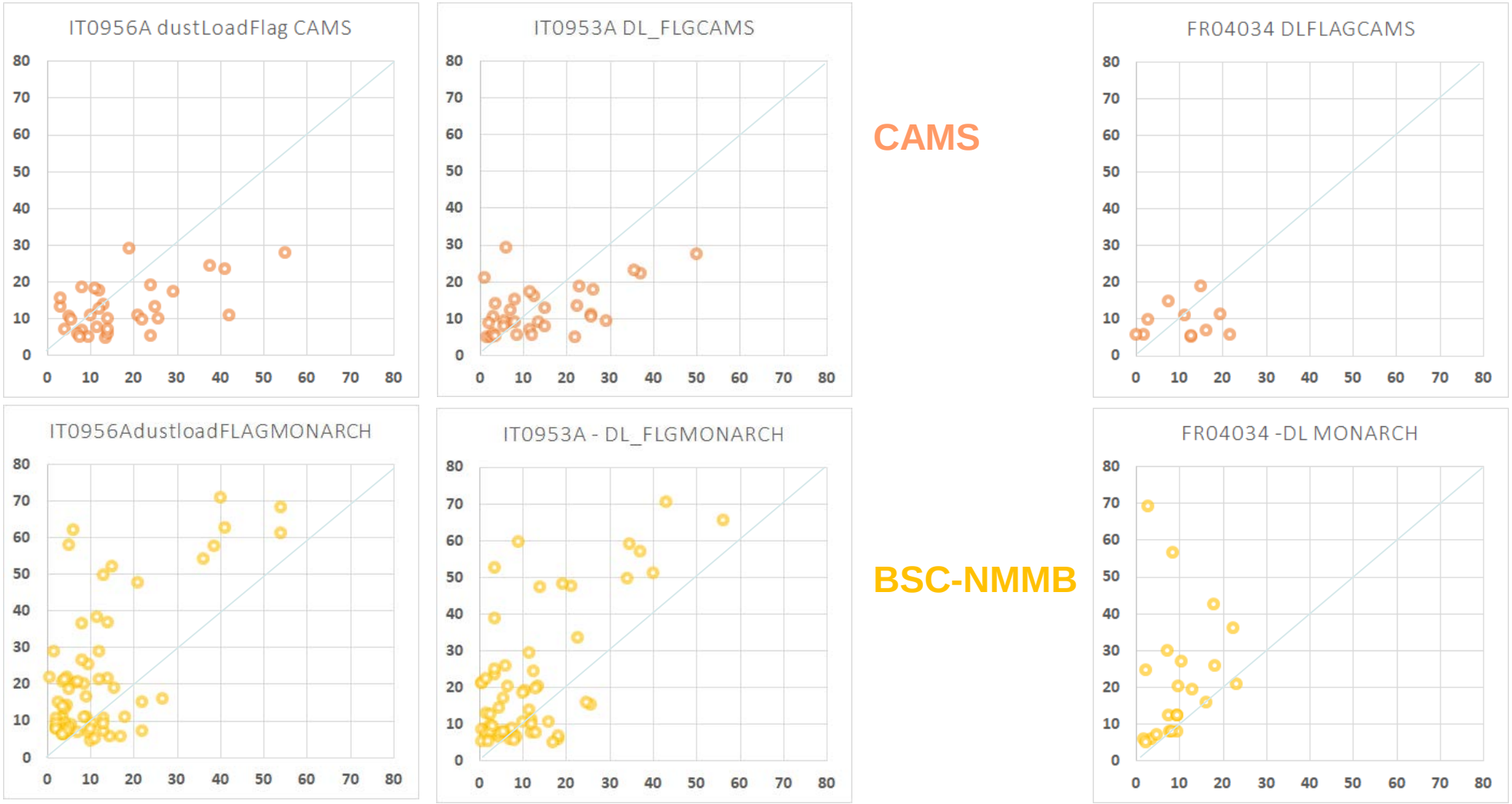
Comparison model-'measurements', **all dust intrusions 2022** in two stations in **Rome** (Cinecittà & Villa Ada) and one station in **Paris** (Vitry-Sur-Seine)



X axis: dust-PM10 from our method

Y axis: dust-PM10 from Models