

QUANTIFICATION OF NATURAL CONTRIBUTION ON PM_{10} EXCEEDANCES IN SOUTHERN ITALY: AN EXPERIMENT PERFORMED IN THE FRAMEWORK OF THE I-AMICA PROJECT

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Outline

- 1 Motivations
- 2 The method and its first application for I-AMICA project
 - Detection of SDE by using just measurements of PM_{10}
 - Quantification of crustal fraction contribution to PM_{10}
- 3 Conclusions

State of the art



European Commission

through its 2008/50/EC directive (ambient air quality and cleaner air for Europe), fixes guidelines for demonstration and subtraction of exceedances due to natural sources

European Environmental Agency - TR No 10/2012

- 1 Interpretation of particulate matter data series (i.e. PM, aerosols size distribution) together with meteorological information (i.e. wind, temperature, relative humidity)
- 2 Remote-sensed data from/at ground-based (i.e. sun-photometers) and satellite (i.e. MODIS, CALIPSO)
- 3 Numerical modeling : regional air quality models (i.e. CHIMERE)

An added value provided by this work



STATISTICAL TREATMENT

is able to provide the list of dusty days and their impact on given period by ingesting only PM_{10} time series collected at all kind of stations (i.e., background rural, background suburban, background urban) in a given area (e.g., Southern Italy).



USEFUL TO

whoever needs to analyze a large amount of data (e.g., at least six months) for a fast recognition of events associated with simultaneous PM_{10} exceedances (e.g., at least for 80% of selected stations).

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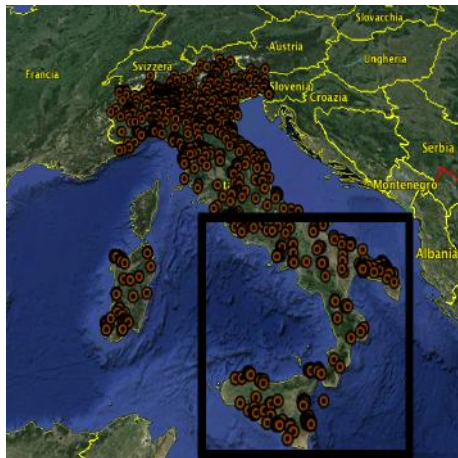


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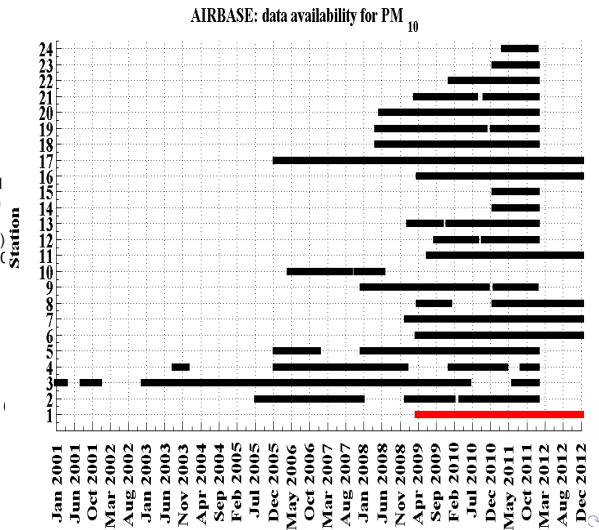
123 stations in Convergence Regions (Southern Italy)

N	Station Class
1	Background Rural (BR)
14	Background Suburban (BS)
9	Background Urban (BU)
13	Traffic Suburban (TS)
56	Traffic Urban (TU)
5	Industrial Rural (IR)
19	Industrial Suburban (IS)
4	Industrial Urban (IU)



24 Background stations in Convergence Regions

1. LECCE (BR 18.1E 40.4N 10m)
2. AUGUSTA (BS 15.1E 37.2N 30m)
3. PALERMO (BS 13.3E 38.1N 141m)
4. NAPOLI (BS 14.2E 40.8N 145m)
5. TARANTO (BS 17.3E 40.4N 10m)
6. MESAGNE (BS 17.8E 40.5N 10m)
7. CAMPISALENTINA (BS 18.0E 40.4N 10m)
8. GROTTAGLIE (BS 17.4E 40.5N 200m)
9. CATANIA (BS 15.0E 37.4N 82m)
10. AGRIGENTO (BS 13.5E 37.3N 180m)
11. CASAMASSIMA (BS 15.2E 40.6N 100m)
12. LOCRI (BS 16.2E 38.2N 10m)
13. MILAZZO (BS 15.2E 38.2N 28m)
14. RAGUSA (BS 14.7E 36.0N 501m)
15. RAGUSA (BS 14.5E 36.7N 24m)
16. TARANTO (BU 17.2E 40.4N 10m)
17. TARANTO (BU 17.2E 40.4N 10m)
18. PARTINICO (BU 13.1E 38.0N 0m)
19. TERMINIIMERESE (BU 13.6E 37.9N 10m)
20. ENNA (BU 14.2E 37.5N 0m)
21. COSENZA (BU 16.2E 39.3N 200m)
22. CROTONE (BU 17.1E 39.0N 10m)
23. RAGUSA (BU 14.7E 36.9N 598m)
24. CATANIA (BU 15.6E 37.5N 135m)

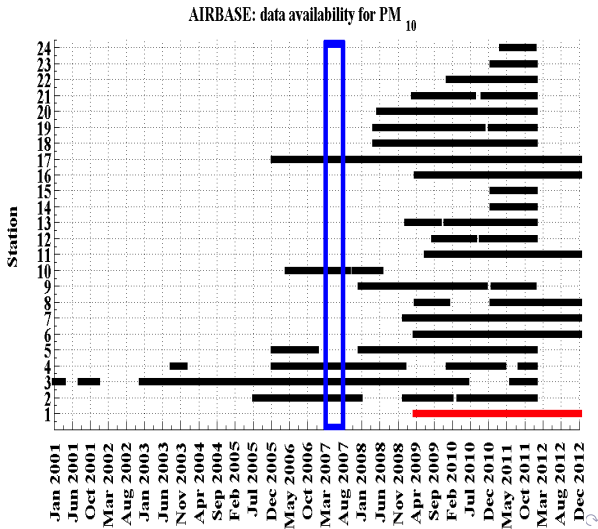


Simultaneous measurements for five stations

- (1) AUGUSTA (BS 15.1E 37.2N 30m)
- (2) PALERMO (BS 13.3E 38.1N 141m)
- (3) NAPOLI (BS 14.2E 40.8N 145m)

- (4) AGRIGENTO (BS 13.5E 37.3N 180m)

- (5) TARANTO (BU 17.2E 40.4N 10m)



Application of the method: Temporal Correlations

→ 2007-3-30

- Exceedance for stations 1 VS 4
- Exceedance for stations 2 VS 1
- Exceedance for stations 2 VS 4
- Exceedance for stations 3 VS 1
- Exceedance for stations 3 VS 4

...

→ 2007-6-22

- Exceedance for stations 1 VS 2
- Exceedance for stations 1 VS 3
- Exceedance for stations 2 VS 1
- Exceedance for stations 2 VS 3
- Exceedance for stations 3 VS 1

...

→ 2007-6-23

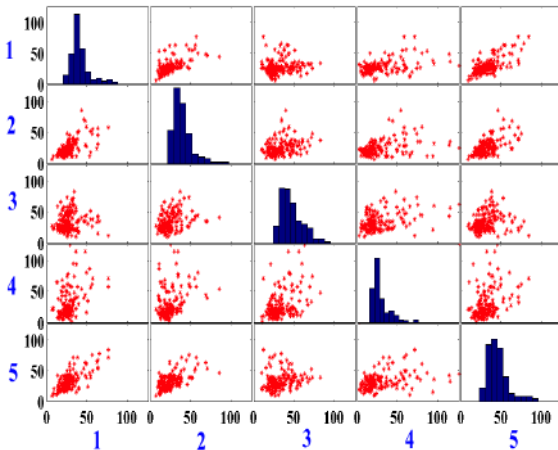
- Exceedance for stations 1 VS 2
- Exceedance for stations 1 VS 5

...

→ 2007-8-27

- Exceedance for stations 2 VS 1
- Exceedance for stations 3 VS 1

...



Method evaluation (DREAM model)

4 Saharan Dust Events (SDE)

13 days with
exceedance

SDE 1 → 2007-3-30

SDE 2 → 2007-6-22

2007-6-23

2007-6-24

2007-6-25

2007-6-26

2007-6-27

SDE 3 → 2007-7-23

2007-7-24

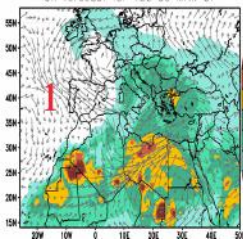
2007-7-25

SDE 4 → 2007-8-25

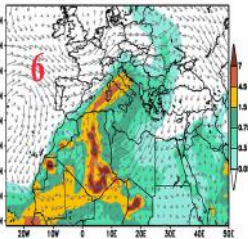
2007-8-26

2007-8-27

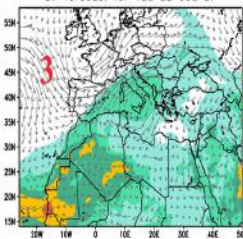
BSC/DREAM Dust Loading (g/m^2) and 3000m Wind
0h forecast for 12z 30 MAR 07



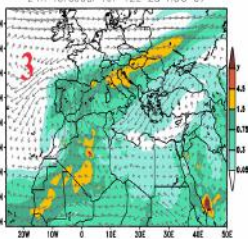
BSC/DREAM Dust Loading (g/m^2) and 3000m Wind
0h forecast for 12z 22 JUN 07



BSC/DREAM Dust Loading (g/m^2) and 3000m Wind
0h forecast for 12z 23 JUL 07



BSC/DREAM Dust Loading (g/m^2) and 3000m Wind
24h forecast for 12z 25 AUG 07



Method evaluation (Elemental analysis)

4 Saharan Dust Events (SDE)

13 days with
 exceedance

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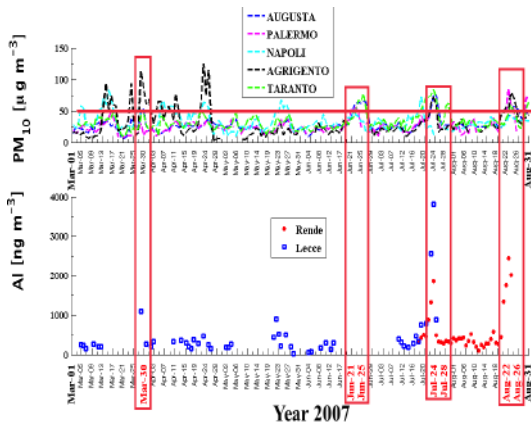
2007-7-24

2007-7-25

SDE 4 → 2007-8-25

2007-8-26

2007-8-27



Elemental analysis was performed by ISAC - CNR (d.contini at isac.cnr.it) and

IIA-CNR (a.bencardino at iia.cnr.it)

Number of Exceedances (Mar-Aug 2007)

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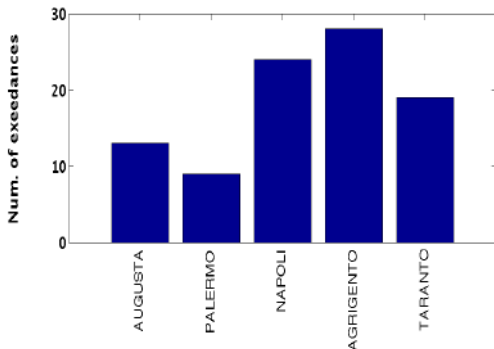
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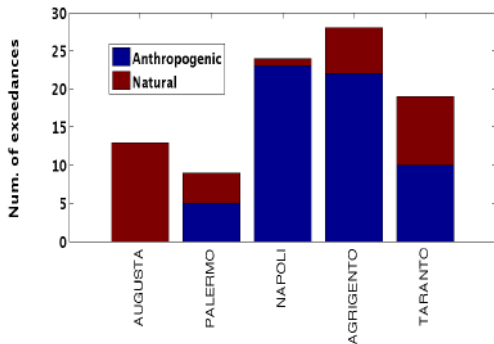
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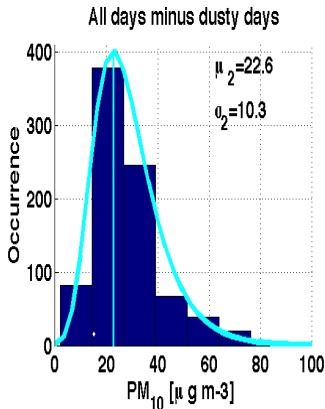
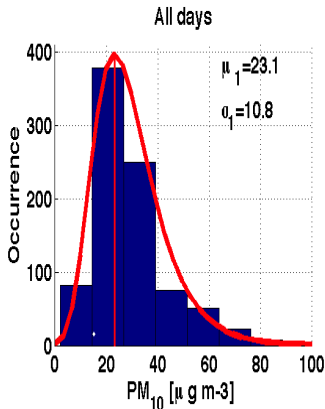
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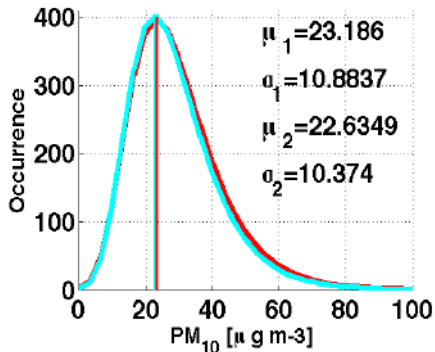
Impact on PM_{10} levels (Mar-Aug 2007)

$$y = f(x|\mu, \sigma) = \sigma^{-1} \exp\left(\frac{x - \mu}{\sigma}\right) \exp\left(-\exp\left(\frac{x - \mu}{\sigma}\right)\right)$$



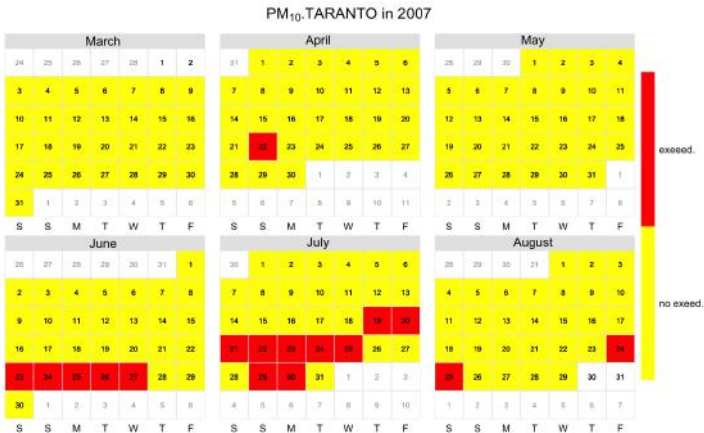
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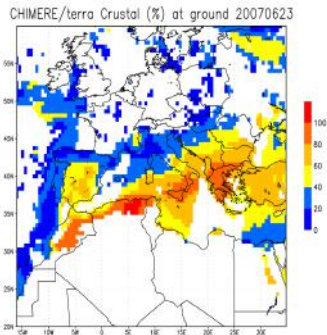
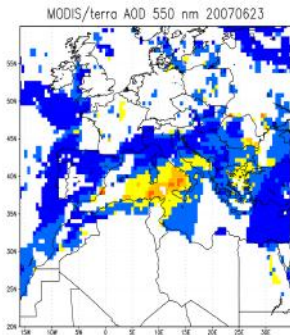
Impact on daily levels of PM_{10}

Calendar with all exceedances



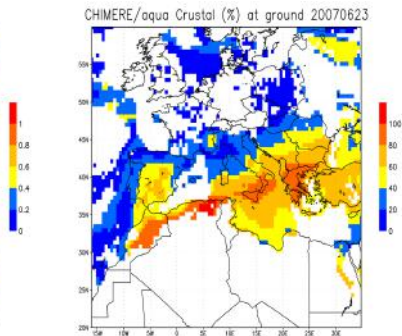
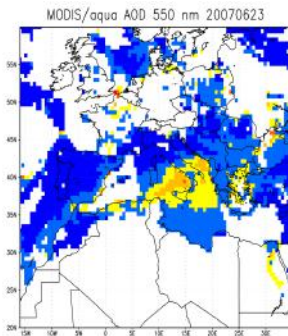
Impact on daily levels of PM_{10}

Satellite observations and modeling system



Impact on daily levels of PM_{10}

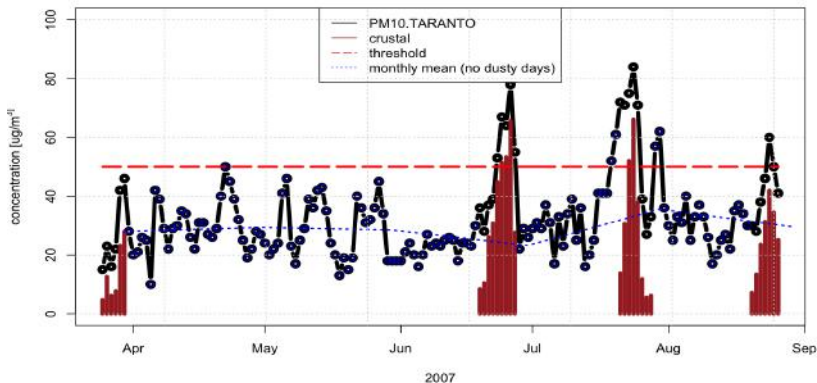
Satellite observations and modeling system



Impact on daily levels of PM_{10}

$$\text{crustal } [\mu\text{g}/\text{m}^3] = (\text{DUST}_{\text{mod}} / \text{PM10}_{\text{mod}}) \times \text{PM10}_{\text{obs}}$$

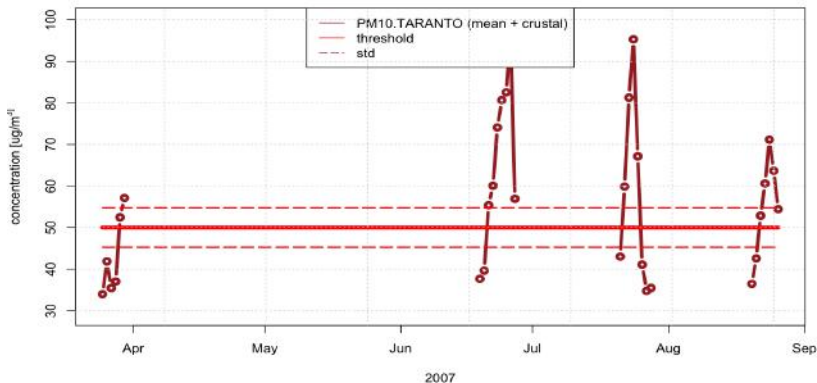
The number of exceedancies is generally overestimated by the model, but they are captured at the right time
 (Rea, Torquety, Menut et al., 2015 ACPD)



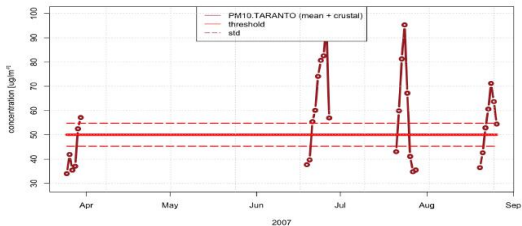
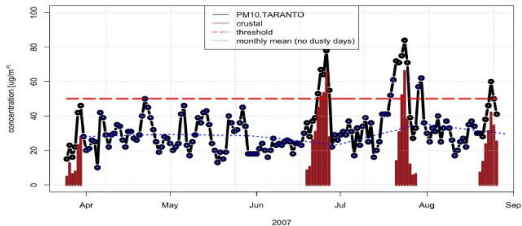
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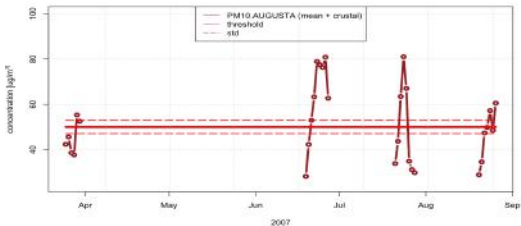
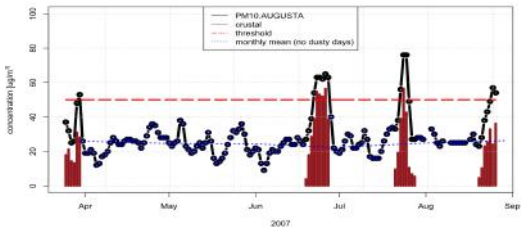
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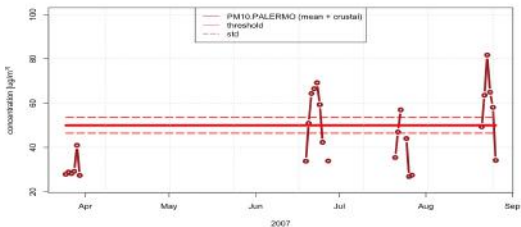
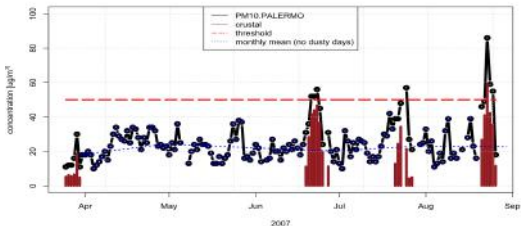
Impact on daily levels of PM_{10}



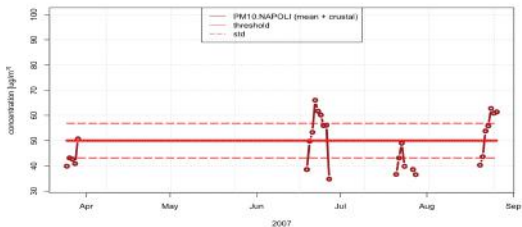
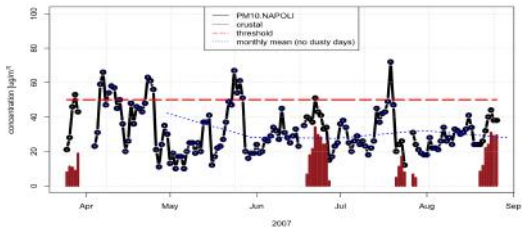
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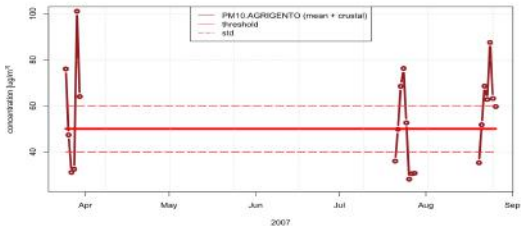
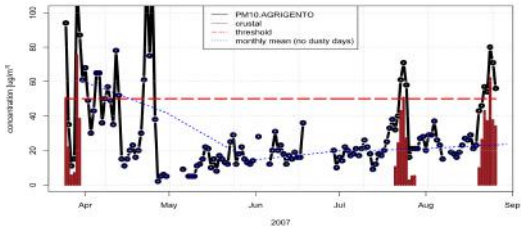
Impact on daily levels of PM_{10}



Impact on daily levels of PM_{10}



Impact on daily levels of PM_{10}





Our findings achieved so far

- 1 The method we used provides encouraging results for the first application in the framework of I-AMICA project
- 2 By using the proposed method, simultaneous measurement of PM_{10} levels for several sampling sites on a regional scale (more than 150 km x 150 km) is the main ingredient for an automatic detection for major dust storms
- 3 Modelling system and satellite data are required for shedding light on quantification of crustal fraction on PM_{10} concentrations at given sampling site on daily basis.