Sorgenti, dinamiche di dispersione ed impatto delle polveri fini nel bacino di Terni

B. Moroni[1,2], S. Castellini[1], F. Scardazza[1], M. Angelucci[3], M. Galletti[3], C. Austeri[3], M. Vecchiocattivi[3], S. Crocchianti[4] and D. Cappelletti[2,4]

[1]Dipartimento di Ingegneria Civile e Ambientale, Università di Perugia, Italy
[2] SMAArt, Università di Perugia
[3]ARPA Umbria
[4]Dipartimento di Chimica, Biologia e Biotecnologie, Università di Perugia, Italy

- Controllo dello *status* (event. fenomeni acuti)

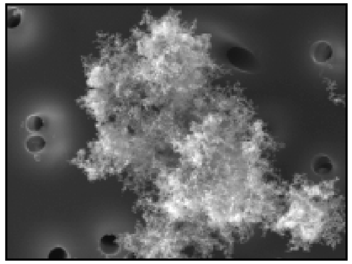
    strumentazione e tecniche consolidate
    standard e valori limite, normativa (EU)

- Comprensione delle cause e definizione delle eventuali strategie di risanamento

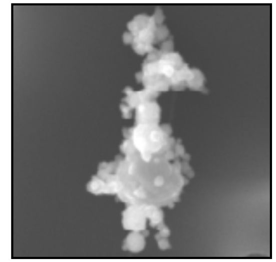
    Strumentazione e tecniche di avanguardia,
    comunità scientifica internazionale

PM_{10}

industria/traffico



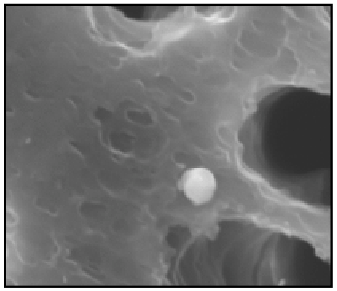
C soot+Fe,Cr



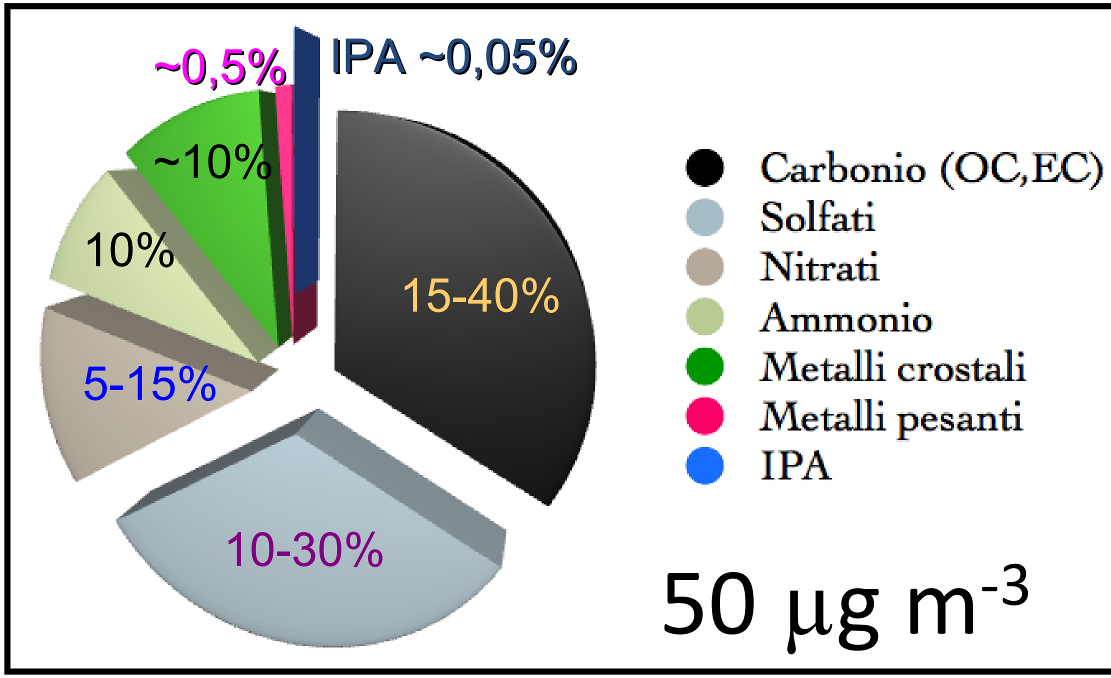
C soot

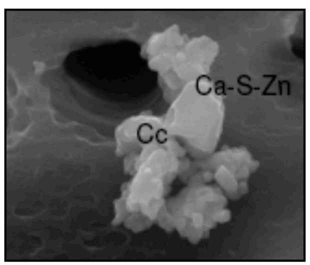
traffico

industria



Fe, Cr, Mn, Zn



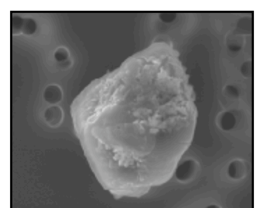


solfati

Ca-S-Zn

traffico/industria/suolo

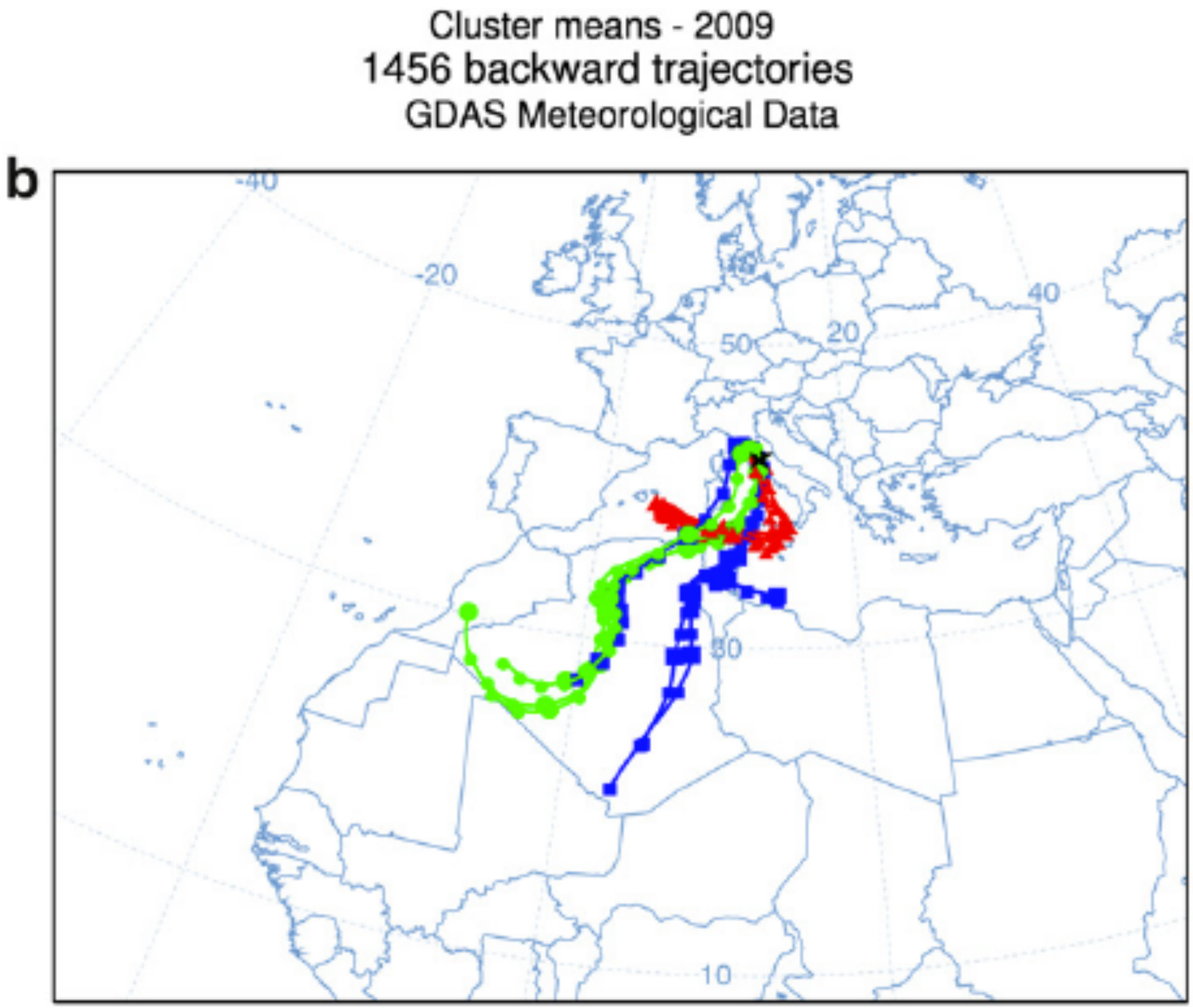
suolo



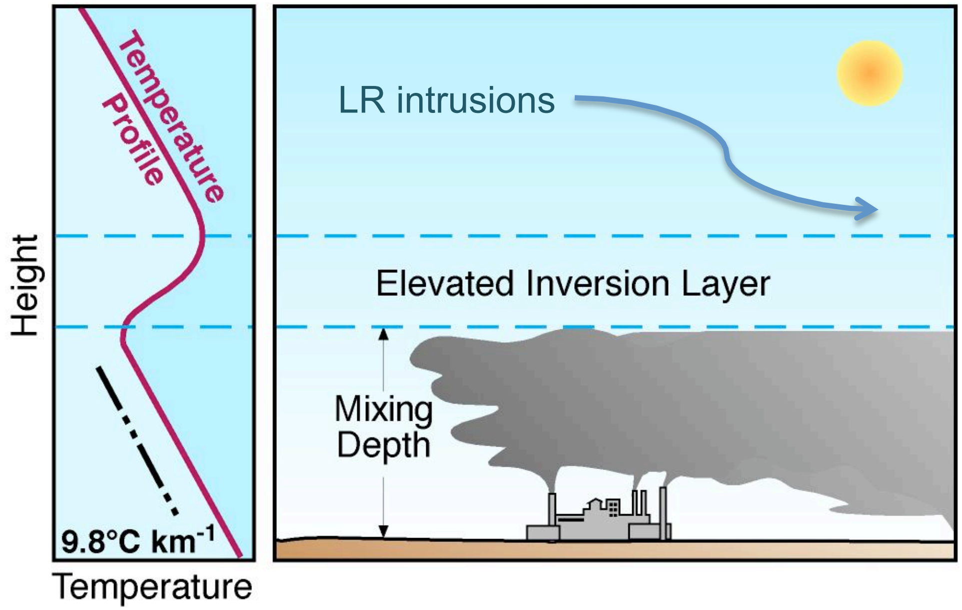
silicati, carbonati, fosfati

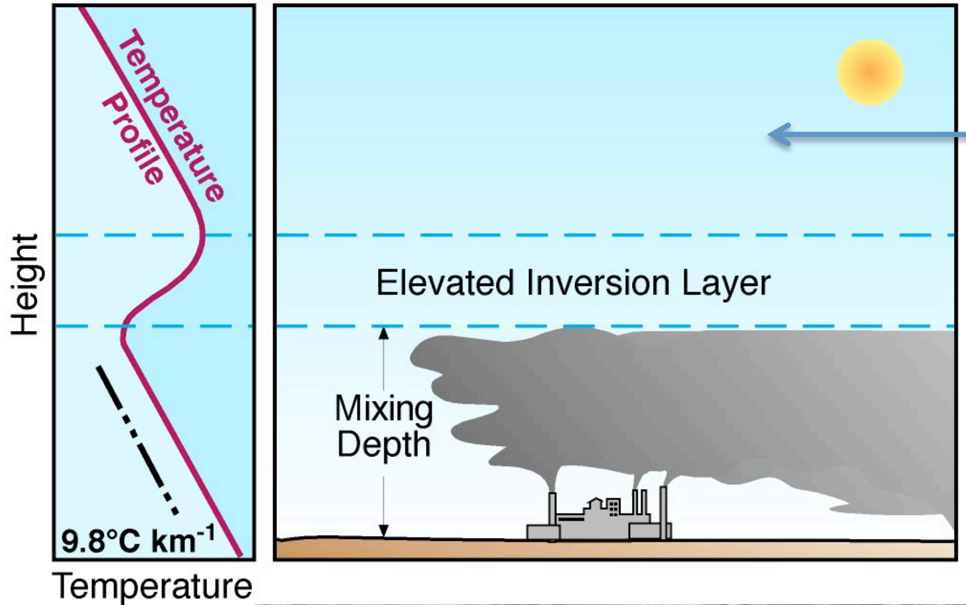
Si (Al-Mg-Ca-K-Na-Fe)

Ca (P)

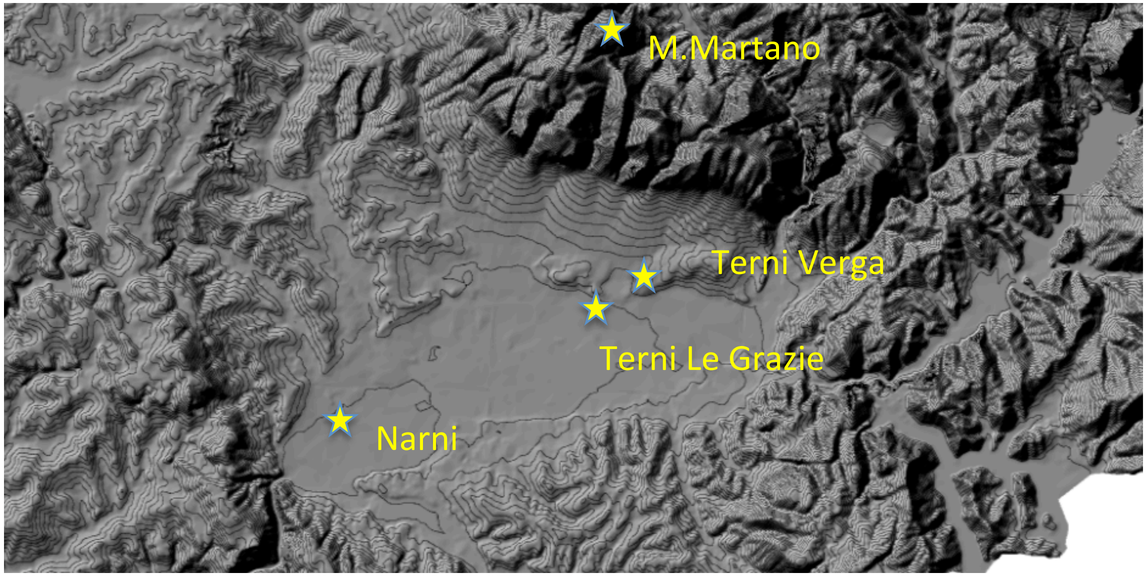

Cluster means - 2009
1456 backward trajectories
GDAS Meteorological Data
b
-40
-20
0
20
40
50
30
10

strato di rimescolamento

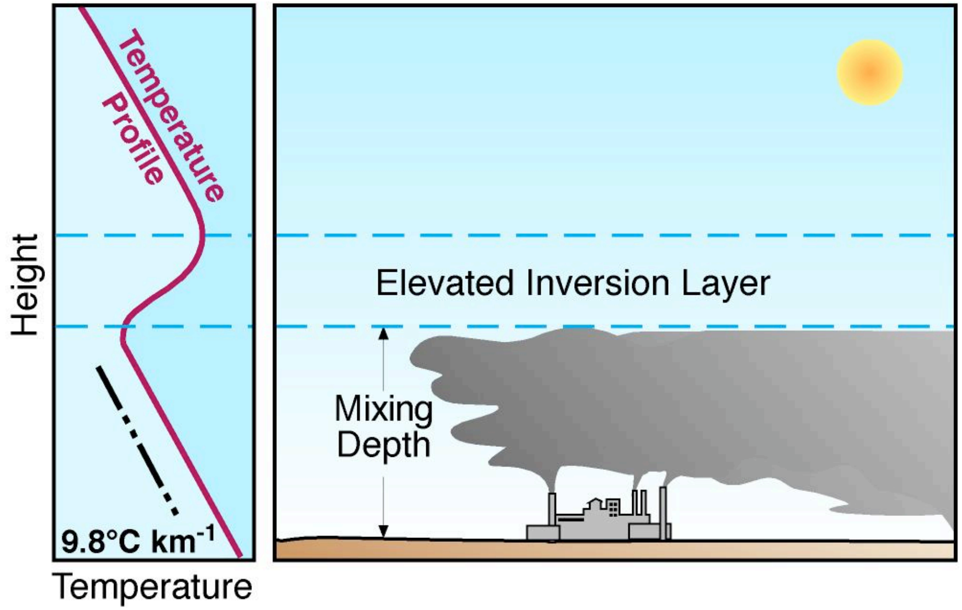


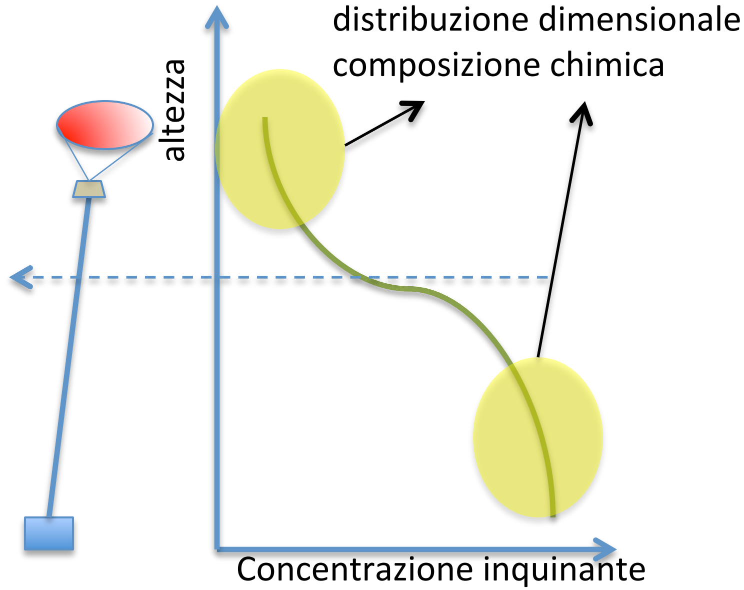


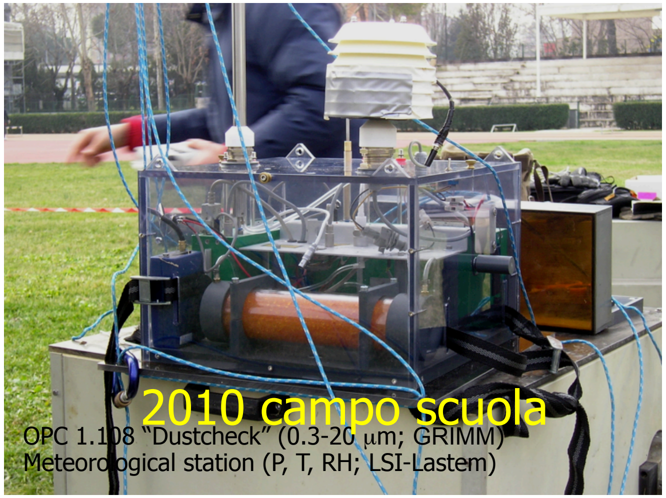
2009
4 siti
4 stagioni
7 classi dimensionali
~40 analiti



profili verticali con pallone aerostatico







caratterizzazione chimica

B. Moroni, D. Cappelletti et al., Atm. Env., 50 (2012) 267-277

Table 2
Mean values of PM mass concentration (μg m^{-3}), and breakdown of element, ion and PAH concentrations (ng m^{-3}) in different sites and seasons. Data are presented as fine (f, D_p<1.3 μm) and coarse (c, D_p>1.3 μm) fractions.

	TR				NR				MM			
	Winter		Summer		Winter		Summer		Winter		Summer	
	f	*c*	*f*	*c*	*f*	*c*	*f*	*c*	*f*	*c*	*f*	*c*
PM	47	23	13	16	16	17	7.0	12	7.4	5.4	9.0	9.1
Pb	27	9.9	5.0	2.4	6.4	2.0	3.2	1.2	1.7	1.2	1.4	0.5
Al	27	167	7.6	35	46	320	8.0	34	12	45	15	33
Fe	170	940	36	115	97	535	30	82	14	64	17	29
Ca	490	2320	120	430	640	1340	100	270	190	440	130	150
Mg	42	130	12	42	53	230	14	33	17	70	14	16
Na	900	600	260	250	1000	1000	250	220	400	600	150	120
K	280	100	3.0	8.9	67	71	5.3	6.4	25	15	5.0	5.0
Cu	23	28	15	5.6	18	16	9.3	2.4	3.2	4.4	4.3	1.0
V	5.2	2.1	0.5	0.2	1.0	0.7	0.4	0.1	0.7	0.3	0.2	0.1
Cr	21	16	5.4	5.5	6.0	6.0	3.6	2.6	0.9	0.8	0.6	0.4
Mn	9.5	16	2.1	3.0	4.7	7.7	1.5	1.5	0.5	1.4	0.1	0.3
Ni	16	11	2.2	2.4	2.6	1.8	1.1	0.7	0.8	1.0	0.1	0.1
Zn	50	47	25	25	33	15	14	7.1	10	10	5.1	2.3
NH_4^+	30	38	520	27	240	12	380	29	150	83	590	40
Cl^-	390	270	110	300	280	860	100	470	44	270	57	35
NO_3^-	5200	1500	1930	1980	2260	1240	1650	2020	1380	1940	1370	1280
SO_4^{2-}	1410	590	2620	630	1370	990	1940	515	1120	520	1960	440
Flu	1.4	0.1	0.002	0.002	0.4	<lod	<lod	<lod	<lod	<lod	<lod	<lod
B(a)P	0.94	0.06	0.099	0.003	0.5	0.1	<lod	<lod	<lod	<lod	<lod	<lod
IP + D(a,h)A	4.2	0.25	0.19	0.010	1.4	<lod	0.1	<lod	<lod	<lod	<lod	<lod
B(ghi)P	1.6	0.08	0.11	0.003	0.9	<lod	<lod	<lod	<lod	<lod	<lod	<lod

Acronyms: Flu = fluoranthene; B(a)P = benzo(a)pyrene; IP = indenopyrene; D(a,h)A = di-benzo(a,h)anthracene; B(ghi)P = benzo(ghi)perylene.

factor analysis: particelle *fine (D<1.3μm)*

Table 3
Fine fraction ($D_P < 1.3$ μm) metals, anions, PAHs: Factor Loadings (source markers evidenced in bold type).

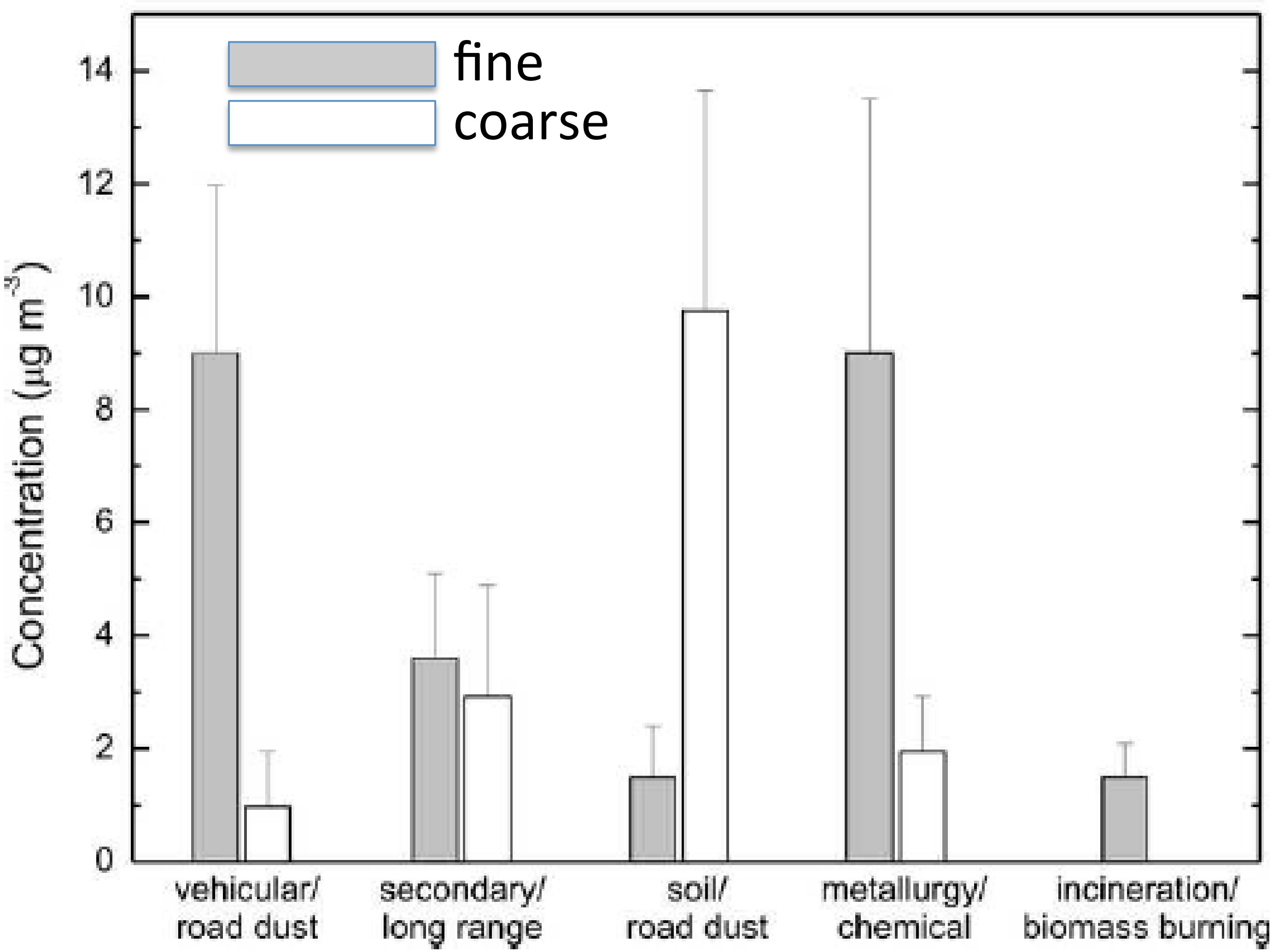
	F1	F2	F3	F4	F5
Pb	**0.38**	0.06	−0.15	**0.72**	**0.35**
Al	−0.03	−0.02	**0.91**	0.26	−0.02
Fe	0.09	−0.13	**0.42**	**0.83**	−0.10
Ca	0.12	0.23	**0.82**	0.10	0.29
K	**0.52**	−0.27	0.19	0.15	**0.73**
Cu	0.15	**0.69**	0.24	0.22	−0.05
V	0.08	−0.03	0.09	0.14	**0.91**
Cr	−0.07	0.12	0.05	**0.91**	0.17
Mn	0.05	−0.19	0.22	**0.91**	−0.13
Ni	0.26	−0.12	−0.05	**0.82**	**0.34**
Zn	−0.24	0.04	0.17	**0.84**	0.11
NH_4^+	−0.35	**0.69**	0.06	−0.23	−0.32
NO_3^-	0.16	**0.76**	0.03	−0.30	0.01
$SO_4^=$	−0.57	**0.47**	−0.03	**0.36**	−0.29
Flu	**0.82**	−0.17	−0.11	0.10	0.28
B(a)P	**0.93**	0.09	0.21	0.04	−0.09
B(ghi)P	**0.85**	−0.04	−0.04	0.08	**0.42**
Eigenvalue	5.99	2.21	1.47	4.22	1.20
% variance	33	12	8.1	23	6.7
Source	Direct vehicular	Secondary	Soil dust	Metallurgy	Incineration/ biomass

factor analysis: particelle coarse (D>1.3μm)

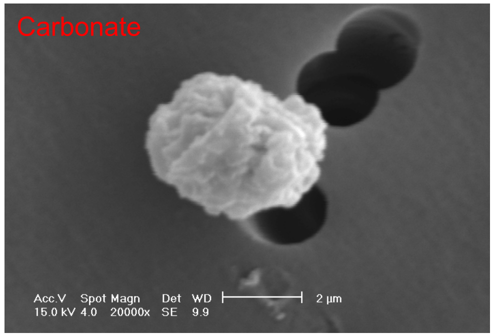
Table 4
Coarse fraction ($D_P > 1.3$ μm) metals, anions, PAHs: Factor Loadings (source markers are evidenced in bold type).

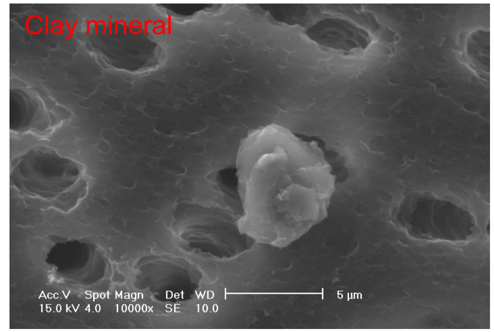
	F1	F2	F3	F4
Pb	**0.69**	0.14	0.24	**0.58**
Al	−0.09	0.10	**0.84**	0.14
Fe	**0.61**	−0.09	**0.63**	**0.41**
Na	−0.04	**0.76**	**0.61**	−0.05
Ca	0.17	0.09	**0.89**	0.21
K	**0.43**	0.00	**0.85**	0.20
Cu	**0.64**	0.02	**0.54**	0.32
V	**0.35**	0.02	**0.68**	0.16
Cr	0.16	0.04	0.22	**0.88**
Mn	**0.60**	0.02	**0.45**	**0.62**
Ni	**0.56**	0.07	0.28	**0.72**
Zn	0.21	0.25	0.14	**0.83**
NH_4^+	0.04	**0.81**	−0.04	**0.40**
Cl^-	−0.14	**0.46**	**0.51**	−0.49
NO_3^-	−0.00	**0.93**	−0.00	−0.16
$SO_4^=$	−0.11	**0.81**	−0.02	**0.41**
Flu	**0.85**	−0.18	0.31	0.12
B(a)P	**0.92**	−0.01	0.10	0.12
B(ghi)P	**0.93**	−0.04	0.09	0.20
Eigenvalue	9.28	2.86	2.17	1.32
% variance	51	16	12	7.3
Source	Vehicular/ road dust	Secondary/ long range	Soil/road dust	Metallurgy/ chemical

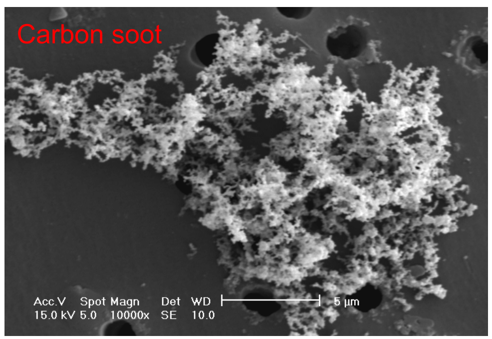
quantificazione delle sorgenti: PM_{10}

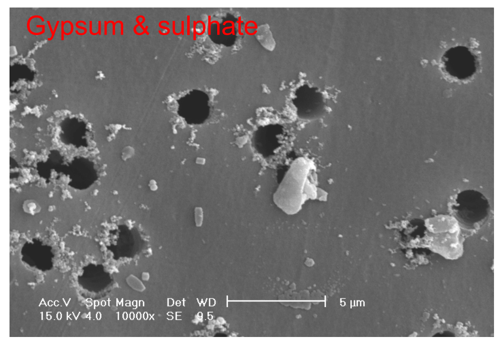


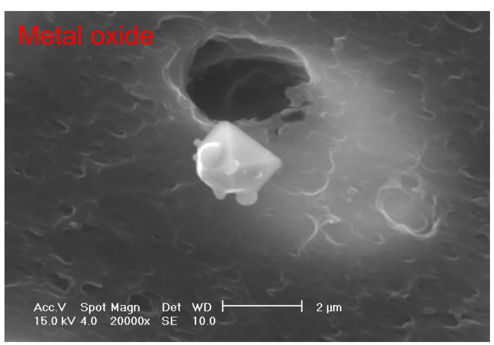
microscopia elettronica: 6 classi di particelle

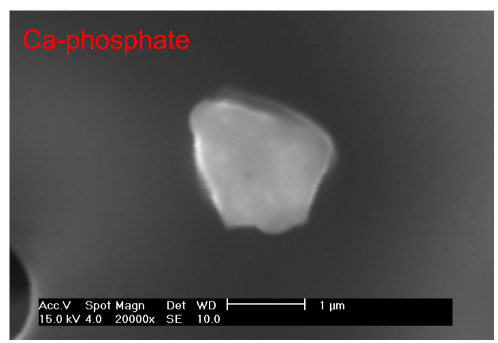




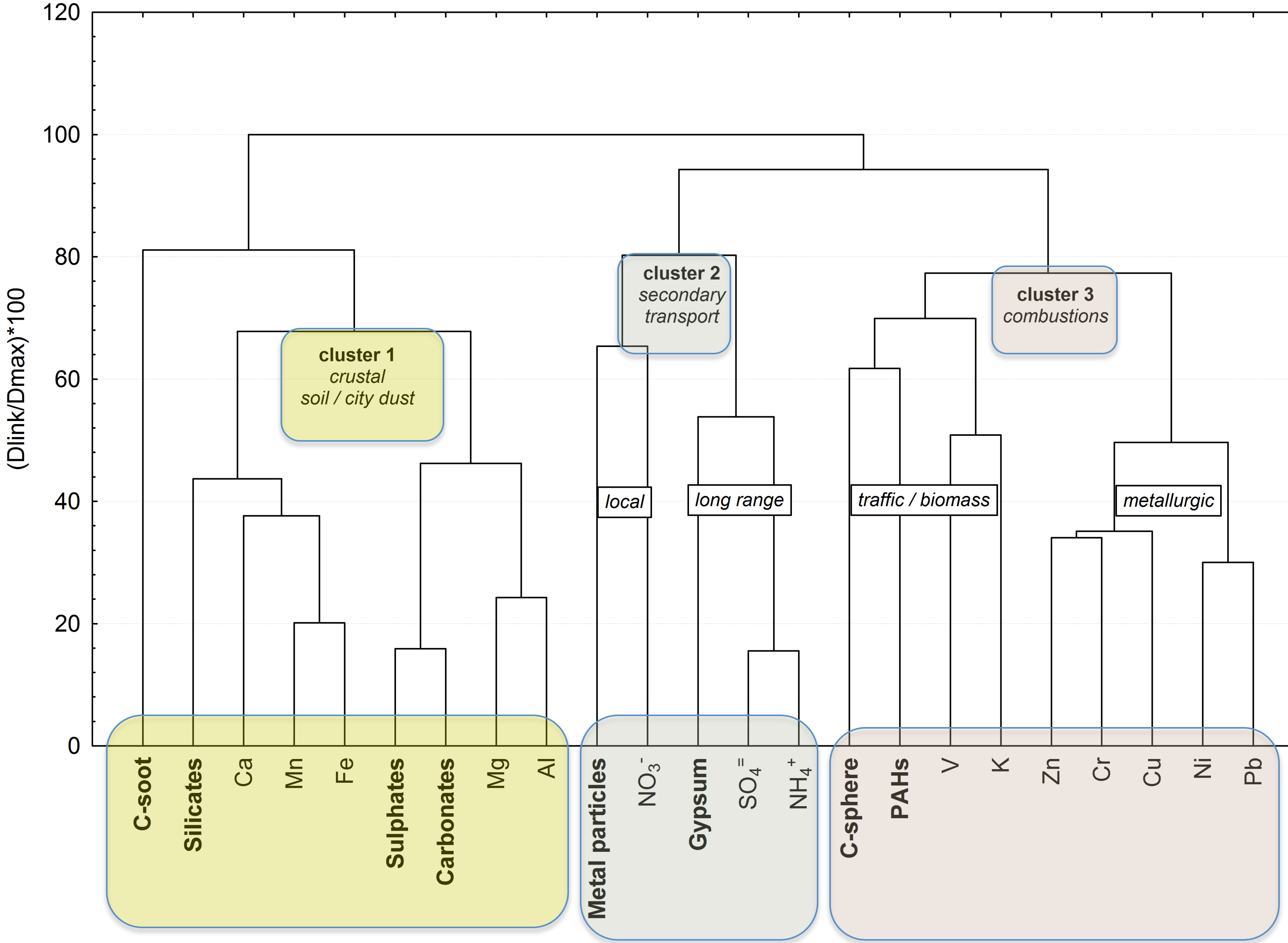




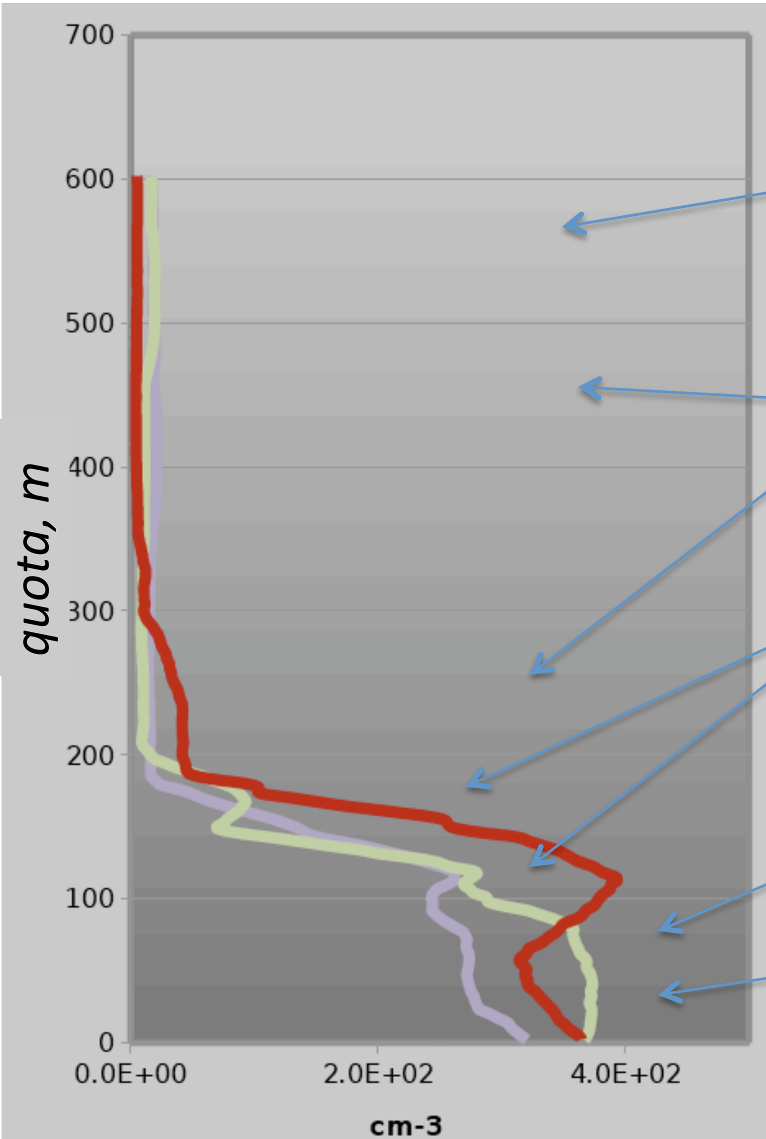




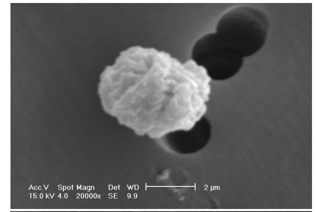
cluster analysis: SEM vs bulk



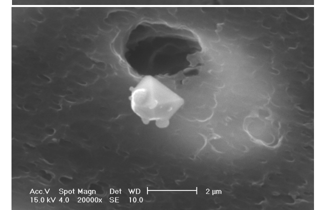
dinamiche di dispersione



numero di particelle

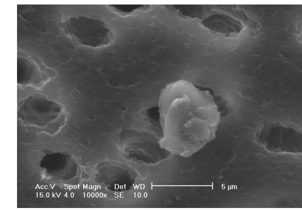


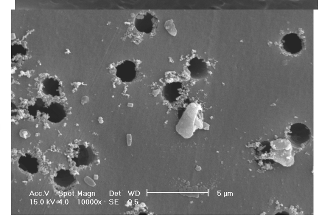
Carbonate



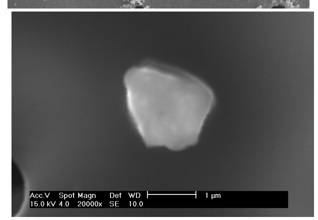
Metal oxide

Clay mineral

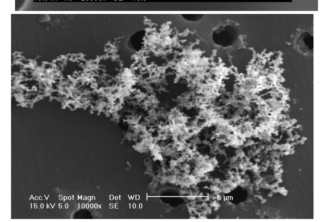




Gypsum & sulphate

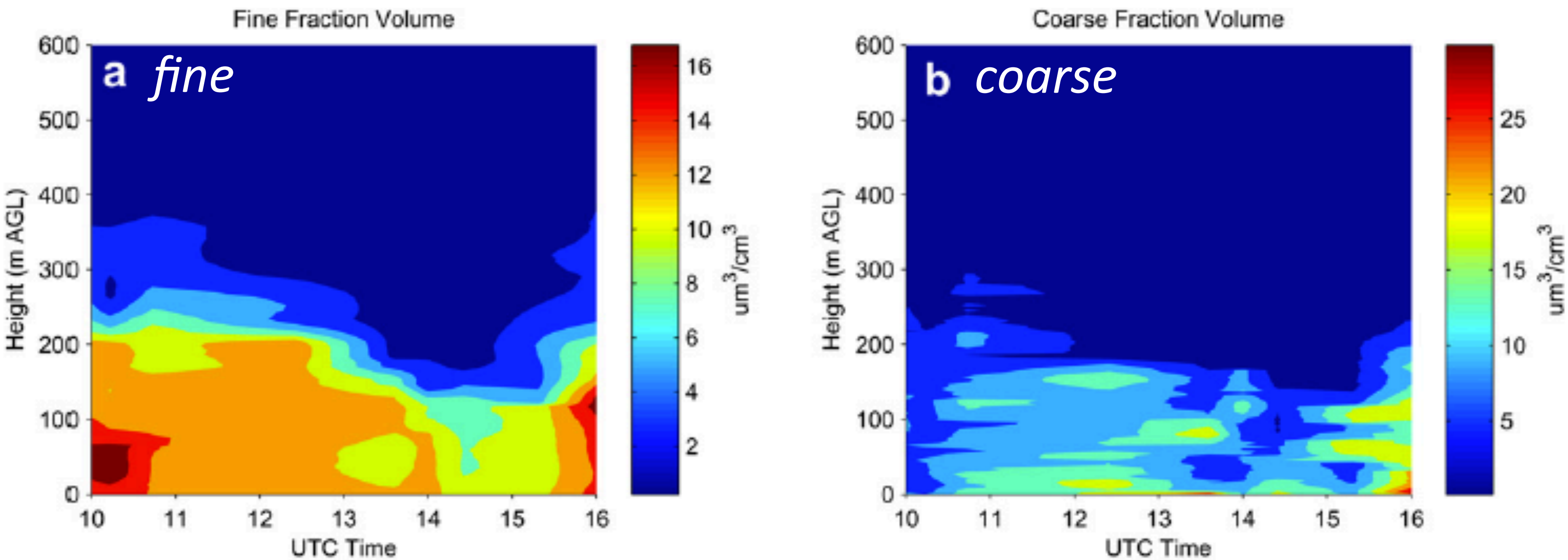


Ca-phosphate



Carbon soot

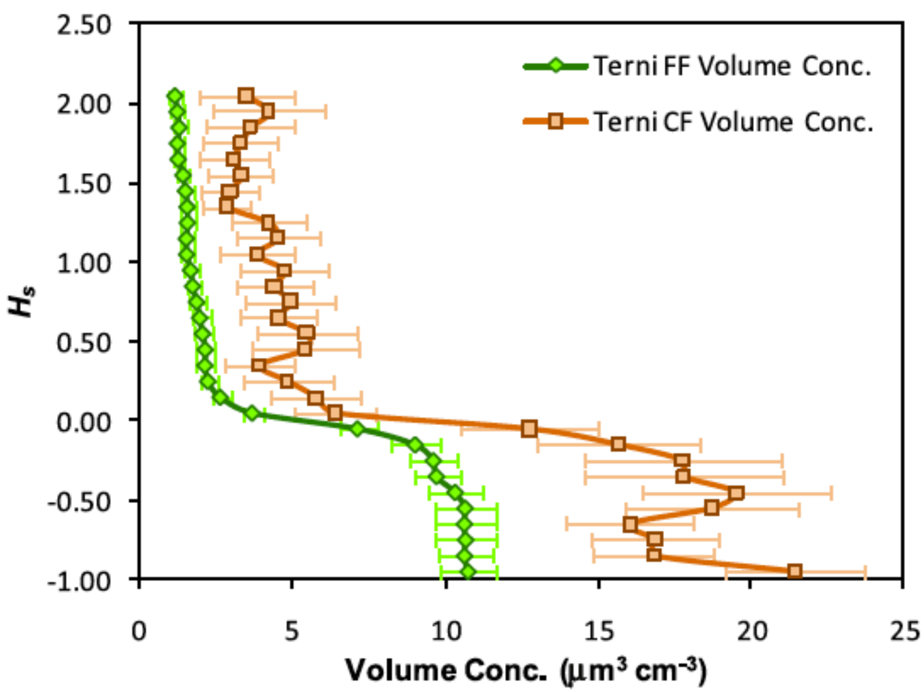
stabilità invernale del boundary layer



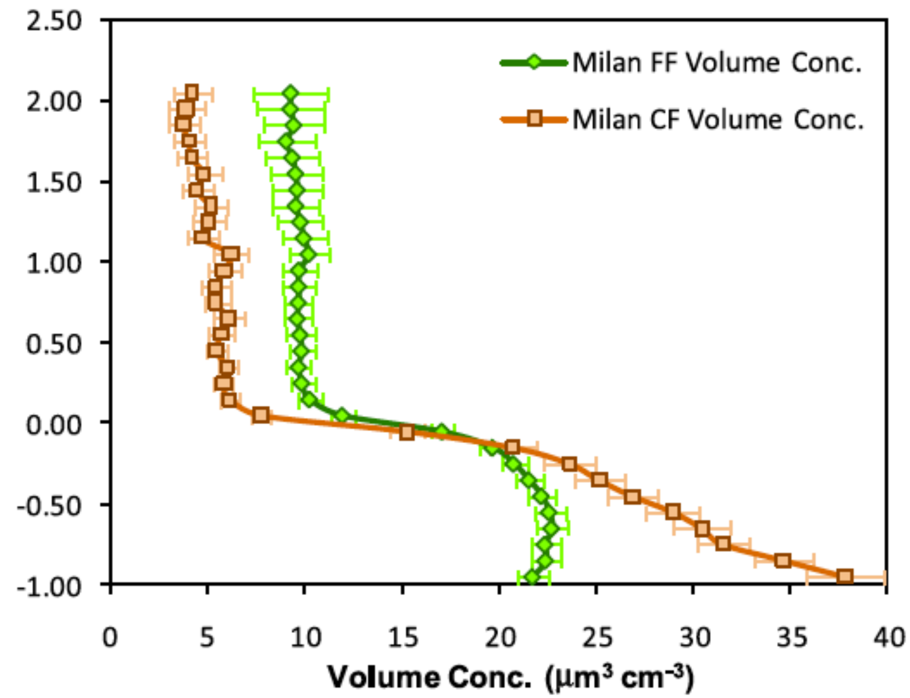
17 gennaio 2009

stabilità invernale del boundary layer

Terni



Milano



L. Ferrero, D. Cappelletti et al., Atm. Env., 56 (2012) 143-153

- Approccio combinato

sorgenti di polvere locali/lungo raggio di origine naturale/antropogenica

dinamiche di dispersione

- Il quadro:

traffico (24%), locale → fine e confinato al suolo

industriale (27%) → fine e coarse, diffuso (suolo ed in quota)

lungo raggio (18%) (regionale, NE Europe, Saharan) →fine e coarse, diffuso (suolo ed in quota)

prospettive

studio della diffusione/dispersione in atmosfera delle nanoparticelle (pallone)?

monitoraggio costante del black carbon (EC/OC) (inventario delle emissioni)?

modellazione dell'apporto a lungo raggio (Sahariane – Martani nella WMO)

correlazione chimica/morfologia versus dati mortalità/incidenza patologie ?

ringraziamenti

finanziamenti: UNIPG

ARPA Umbria

fondazione CARIT Terni e Narni

supporto logistico: Comune di Terni

collaborazioni scientifiche/tecniche

Luca Ferrero, Ezio Bolzacchini (UNI Milano Bicocca)

Mariapina Castelli, Marcello Petitta (EURAC Bolzano)

Luca Barcherini, Stefano Ortu (UNIPG)

Angelo Grilli