



Italian National Research Council
Institute of Atmospheric Pollution Research



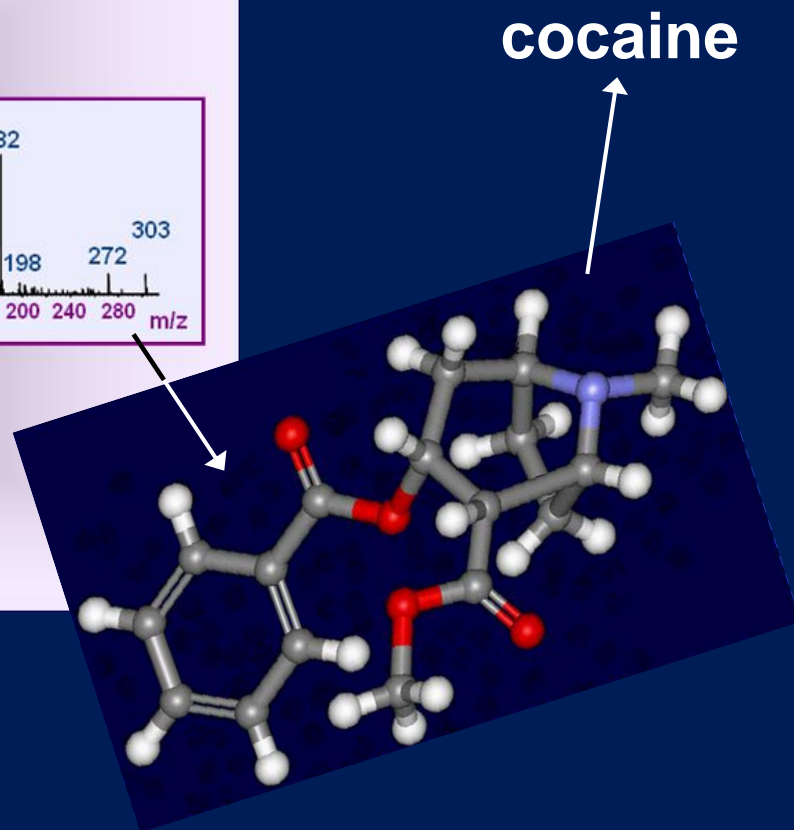
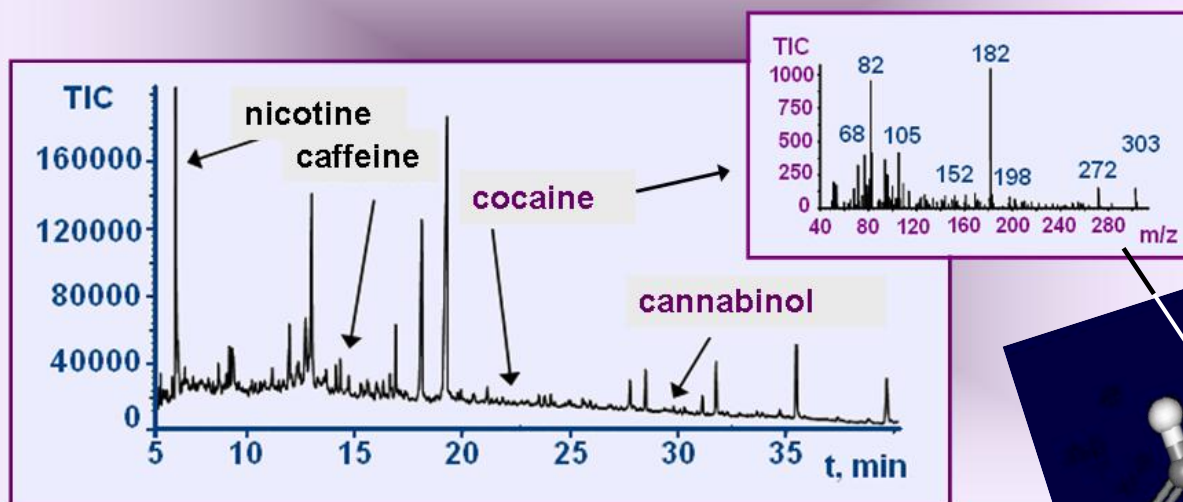
Psychotropic substances in the atmosphere of world cities

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November 5th, 2009 - Rome

Our concern on psychotropic substances started with unexpected and accidental finding of drugs in the air of Rome in 2006...

The cocaine occurrence in the air of Rome, Italy; the first experimental evidence:



However, our team was not the first that made this observation...

... in fact, the first detection of cocaine in urban air was in Los Angeles, in 1993

Environ. Sci. Technol. 1998, 32, 3502–3514

Bioassay-Directed Chemical Analysis of Los Angeles Airborne Particulate Matter Using a Human Cell Mutagenicity Assay

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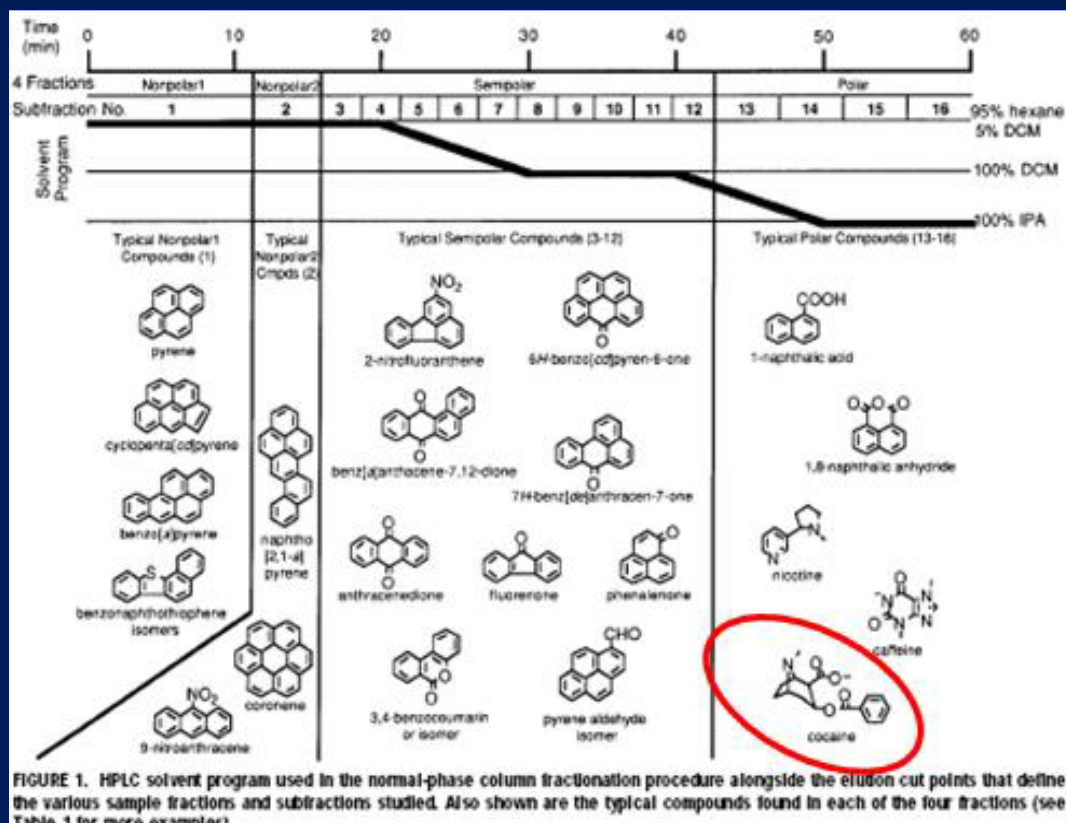
Gentest Corporation, Woburn, Massachusetts 01801

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Cocaine, other illicit drugs and related metabolites have been identified in the river waters

of Italy...

...and England

Table 2 – Illicit drug residues (ng/L) in the rivers Olona and Lambro

Drugs	River Olona	River Lambro
Benzoylcegonine	183	50
Cocaine	44	15
Norbenzoylcegonine	8.4	3.2
Norcocaine	3.6	0.4
Cocaehtylene	1.3	0.2
Amphetamine	<0.65	<0.65
Methamphetamine	1.7	2.1
MDA	<1.18	<1.18
MDMA	1.7	1.1
Morphine	38	3.5
6-acetylmorphine	<0.93	<0.93
THC-COOH	<0.48	3.7
Codeine	51	12
6-acetylcodeine	<0.31	<0.31
Methadone	8.6	3.4
IDDP	18	9.9

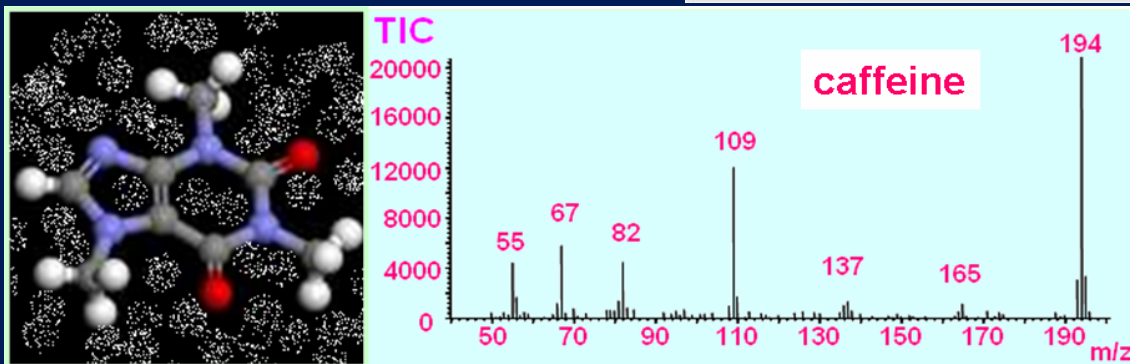
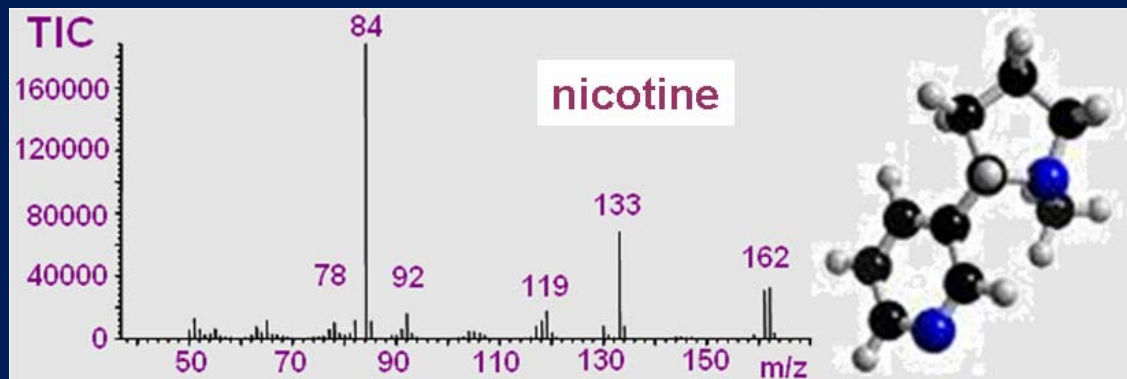
Table 5 – Illicit drug residues (ng/L) along the River Thames

Drugs	New Bridge	Shillingford Bridge	London, Chiswick Bridge ^a	London, Houses of Parliament	London, Tilbury ^a
BE	4	6	17 ± 0.8	16	13 ± 0.6
Cocaine	<0.13	<0.13	4 ± 0.6	6	4 ± 0.1
Amphetamine	<0.65	<0.65	<0.65	<0.65	<0.65
Methamphetamine	<0.41	<0.41	<0.41	<0.41	<0.41
MDA	4	2	3 ± 0.3	3	<1.18
MDMA	2	2	4 ± 0.4	4	6 ± 0.3
Morphine	<0.55	5	42 ± 4.7	9	7 ± 0.7
THC-COOH	<0.48	<0.48	1 ± 0.6	<0.48	<0.48



Together with cocaine, the two major recreational drugs, namely nicotine and caffeine were detected in Rome.

Similar results were found by analyzing air samples from Milan and Taranto, Italy.



Surprisingly, measurements of nicotine and caffeine in open air are very few, although these compounds are widespread



Since cocaine was present in almost all samples processed, an analytical procedure was set up for measuring it precisely and accurately at the concentrations usually expected (namely 0.001 to 1.0 ng/m³ of air)

Flow diagram of cocaine analysis through GC-MSD

- **COLLECTION OF AIRBORNE PARTICULATE**
(medium- or high-volume sampling)
 - **SPIKING WITH DEUTERATED STANDARD**
(cocaine-d₃)
 - **EXTRACTION WITH ORGANIC SOLVENT**
soxhlet (DCM/ACE)
 - **RESIDUE FRACTIONATION INTO THREE CLASSES of POLARITY**
(column chromatography)
- HIGHLY-POLAR FRACTION**
- **IDENTIFICATION AND EVALUATION OF COCAINE**
(GC-MSD analysis, sim mode)



Cocaine was monitored in spotty samples collected in downtown Rome, Taranto, Bari and Milan, Italy, from 2004 to 2007. For sake of completeness also nicotine, caffeine and benzo(a)pyrene were measured.

Cocaine measurements in four Italian cities and comparison with recreational drugs and BaP

ng m ⁻³	city			
	Milan	Rome	Taranto	Bari
nicotine	18.0	11.0	3.10	19.4
caffeine	1.30	3.32	0.14	0.12
methadone	n.d.	n.d.	n.d.	n.d.
cocaethylene	n.d.	n.d.	n.d.	n.d.
cocaine	0.21	0.06	0.01	0.01
cannabidiol	X	X	n.d.	n.d.
heroin	n.d.	n.d.	n.d.	n.d.
benzo(a)pyrene	1.50	0.50	1.19	0.86



More extensive measurements were carried out in Rome.

1. The first dedicated campaign was conducted during 2005-06, at locations lying inside and outside the city centre.

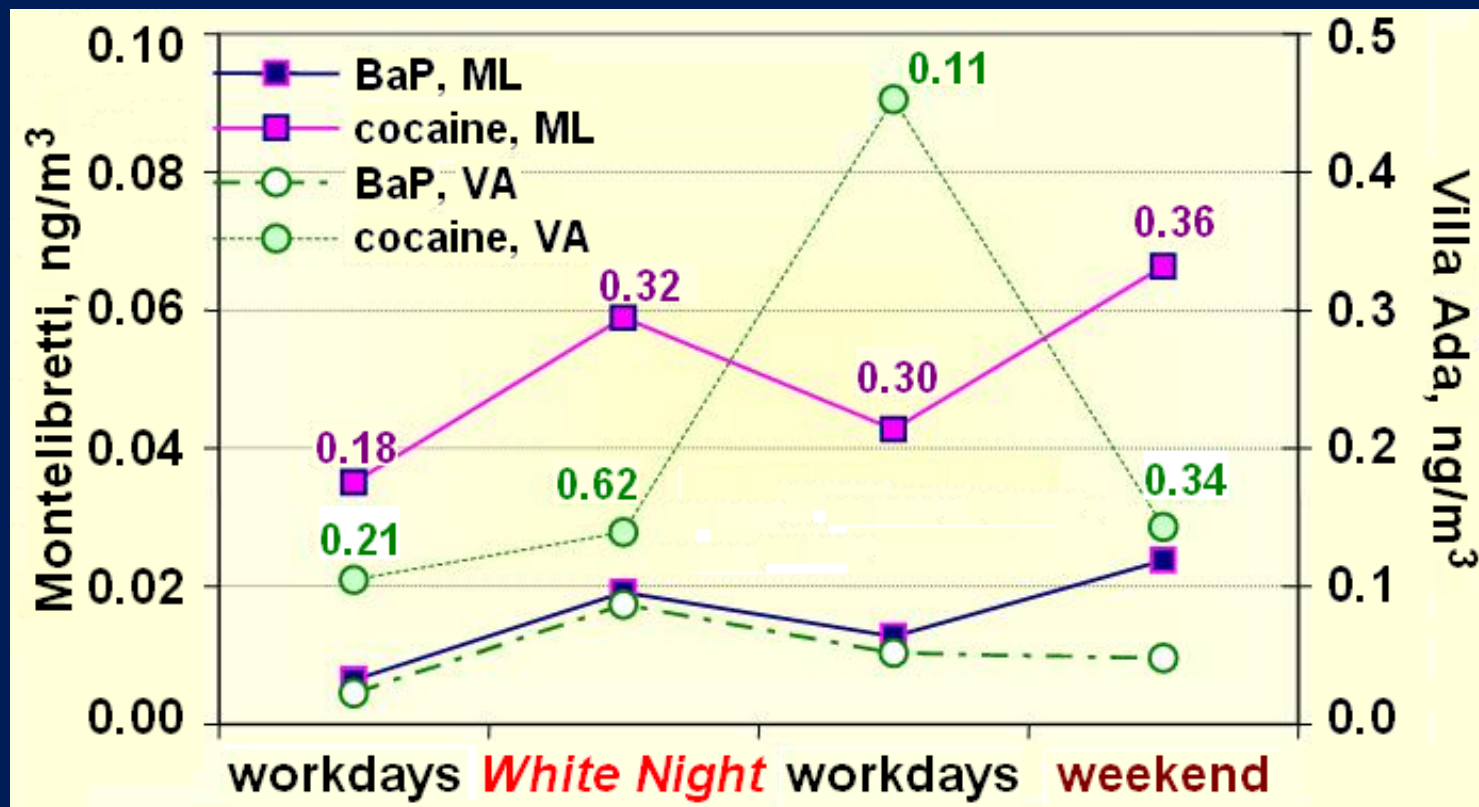
year	locality ng m ⁻³	Rome district				
		v.le Regina	v. Bissolati	v. Belloni	p.za Fermi	Villa Ada
2005	Cocaine	0.098	0.012	0.021	0.015	0.07
	BaP	1.15	0.26	0.07	0.52	0.29
2006	Cocaine	n.eva.	0.036	0.069	0.069	0.052
	BaP	n.eva.	0.67	0.27	1.43	0.210

year	locality ng m ⁻³	metropolitan zone	
		Malagrotta	Montelibretti
2005	Cocaine	n.eva.	0.011
	BaP	n.eva.	0.65
2006	Cocaine	0.047	0.015
	BaP	0.138	0.051

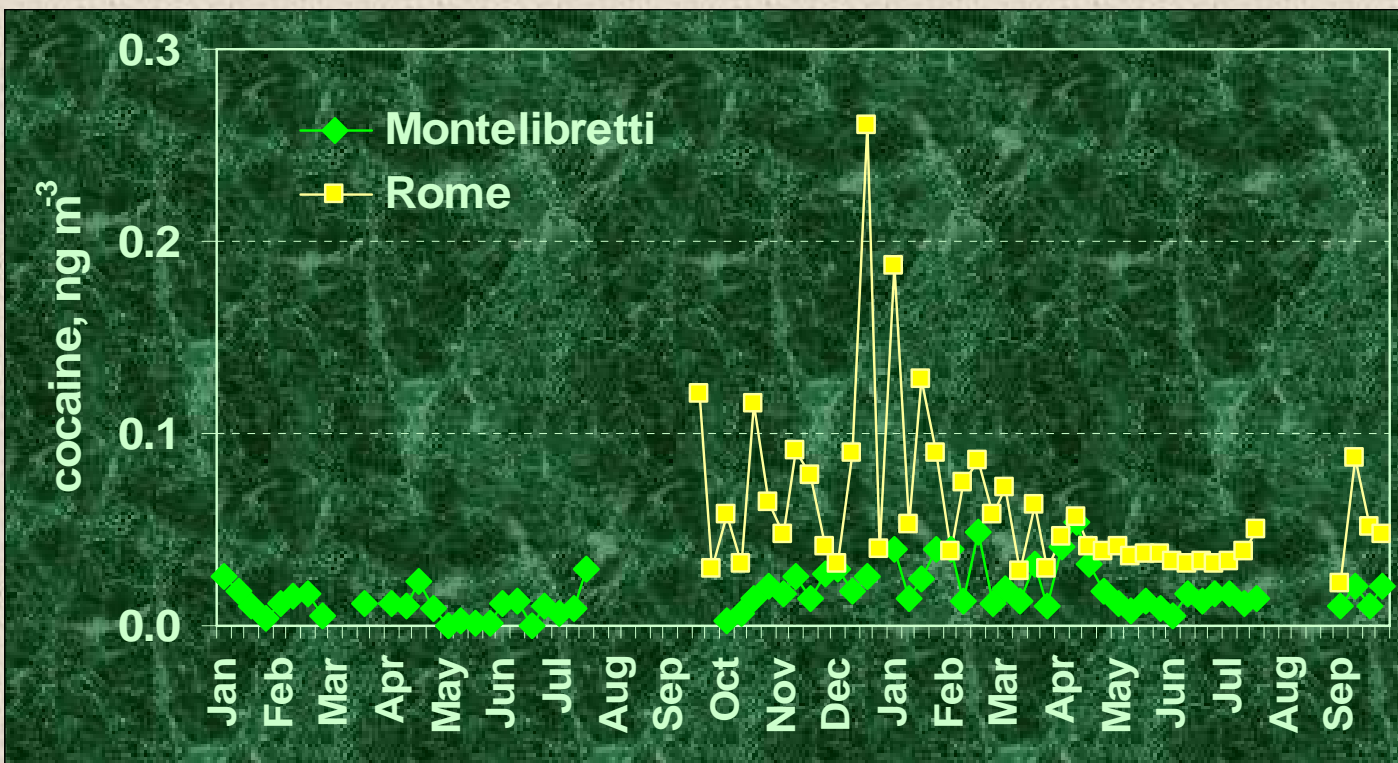
V.Le Regina, v. Belloni: resi. areas
v. Bissolati, p.za Fermi: city centre,
rush traffic sites
Villa Ada: city garden (background)
Malagrotta: suburban, industrial
Montelibretti: extra-urban, rural



2. Second, cocaine was monitored in September 2007, on weekdays and weekends and especially during the White Night fest event



3. Finally, a long time campaign was performed both in Villa Ada (downtown Rome) and at Montelibretti (extra-urban, semi-rural) with weekly measurements



Airborne concentrations (ng m⁻³) of nicotine, caffeine and illicit compounds in Milan (2006-07): year time modulation

compound	Jun	Aug	Sep	Dec	Jan	Feb	C.mas
nicotine	7.52	7.44	34.69	10.40	5.77	53.5	6.64
caffeine	0.17	0.07	0.40	4.91	0.69	1.00	1.92
cocaine	0.073	0.097	0.216	0.080	0.252	0.266	0.470
cannabidiol	< 0.005	< 0.005	< 0.005	0.009	0.037	< 0.005	0.038
Δ^9 -THC	0.027	0.027	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
cannabinol	0.074	0.098	< 0.005	< 0.005	< 0.005	< 0.005	0.574

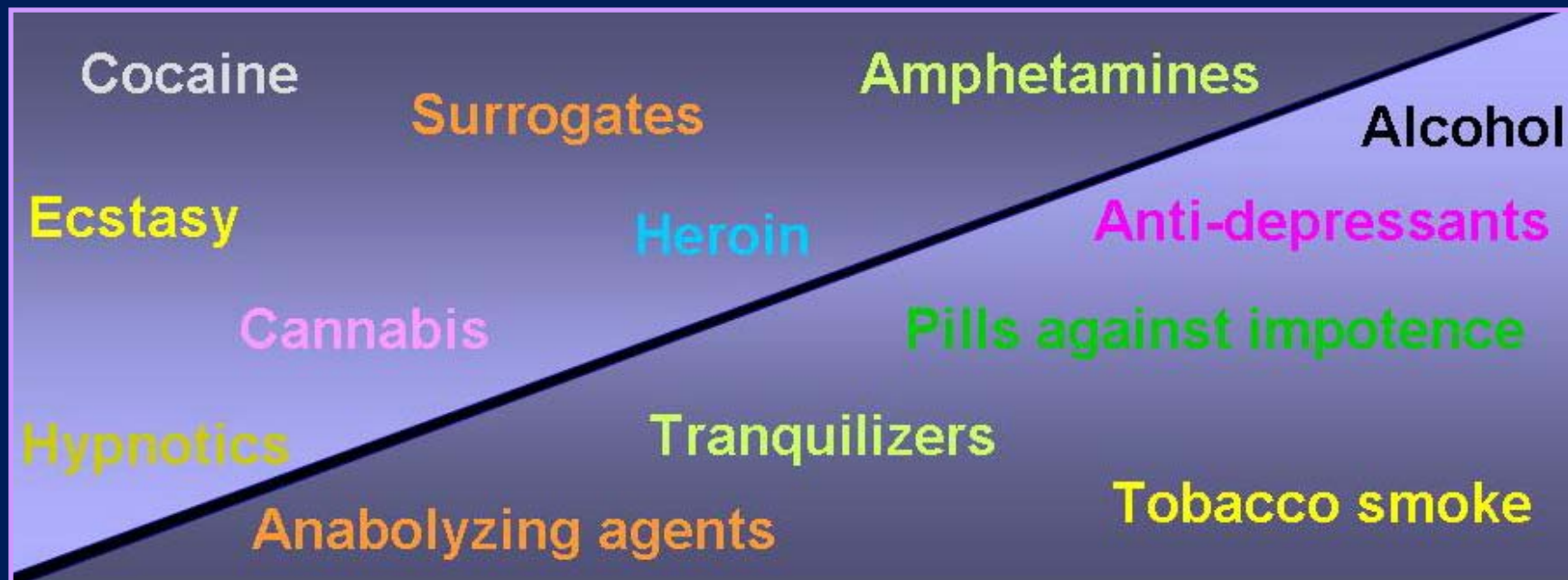


Cocaine contents in the air of world cities (2002-'07)

country	site, city (year)	period	nicotine, ng m ⁻³	caffeine, ng m ⁻³	BaP, ng m ⁻³	cocaine, pg m ⁻³
Portugal	Oporto	Su.	5.1	2.1	0.67	148
Serbia	Pančevo (urban)	Year	22	0.16	2.3	< LOD
	Pančevo (suburb)	Year	8.4	0.02	1.55	< LOD
Algeria (Algiers)	Tafourah,	Su.	10.9	1.7	0.58	< LOD
	Roubia	Su.	6.3	6.7	0.14	< LOD
	Reghaia	Su.	7.8	3.4	0.18	< LOD
Chile	Santiago	Wi	14.4	12.4	4.4	2,800
Brazil	Sao Paulo ('03)	Wi	9.8	6.2	1.16	590
	Sao Paulo ('07)	Au.	15.6	0.29	0.50	250
	Piracicaba ('03)	Wi	2.6	0.78	1.15	76
	Piracicaba ('07)	Wi	3.7	0.14	0.80	89
	Araraquara ('03)	Wi	1.93	4.6	0.50	101
	Ouro Preto ('02)	Wi	3.9	0.31	21	47
	Ouro Preto ('03)	Au.	10.1	0.34	38	101



Cocaine is only one among the numerous (licit and illicit) psychoactive chemicals widely (ab)used



Surprisingly, almost no data exist about the drug occurrence in the air; even nicotine and caffeine are not taken in account



Cannabinoids detected in Rome, Montelibretti RM, Bari and Milan (concentrations in pg m^{-3})

compound	site	Rome, Sep.'08	Rome, Oct.'08	ML, Sep.'08	ML, Oct.'08	Bari, Mar.'07	Milan, '06-'07
Δ^9 -THC		44 ± 5	104 ± 61	30 ± 5	58 ± 15	39 ± 7	9 ± 10
cannabidiol		3 ± 1	6 ± 3	2 ± 1	< 1	2 ± 1	13 ± 11
cannabinol		39 ± 10	70 ± 22	17 ± 5	19 ± 10	32 ± 8	62 ± 70



Cannabinoids detected in some world's cities (concentrations in pg m^{-3})

compound	site	Pančevo, '06-07	Oporto, Jul'07	Santiago, wi. '06	Sao Paulo, '06-'07	Piracicaba, '06-'07	Algiers, Oct.'07
Δ^9 -THC		< 1	< 3	< 1	4 ± 4	13 ± 18	< 1
cannabidiol		36 ± 32	3 ± 3	< 1	13 ± 12	56 ± 41	< 1
cannabinol		22 ± 20	10 ± 12	35 ± 17	84 ± 82	19 ± 19	10 ± 2



The 2009 Monitoring Campaign of Cocaine in Italy: the rationale

- ➔ two sets of experiments, in winter and summer;
- ➔ two weeks of measurements per season;
- ➔ several cities over the Italian territory;
- ➔ sites of different anthropogenic impact, in Rome and across Italy;
- ➔ the main particulate pollutants measured in parallel.

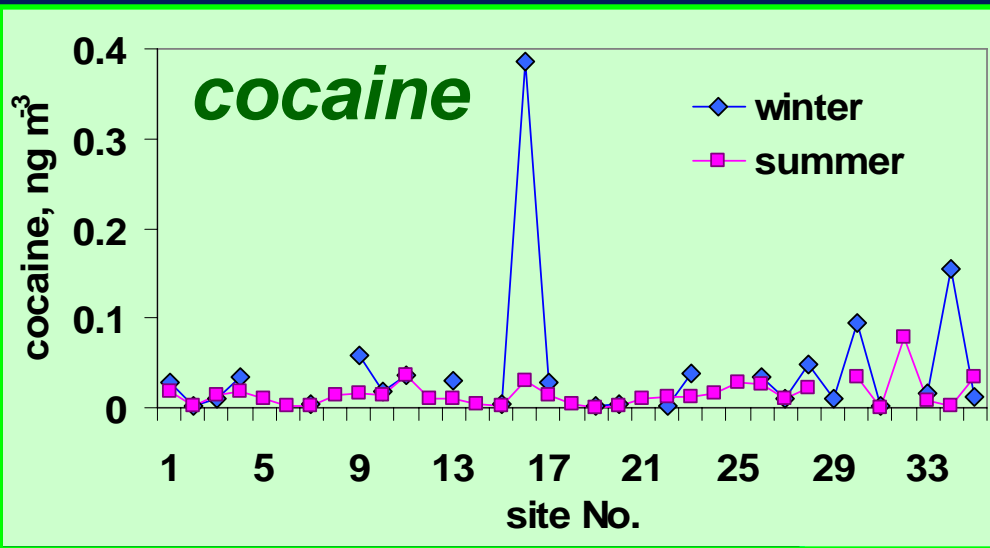


*The 2009 Monitoring Campaign of Cocaine in Italy:
the site location*



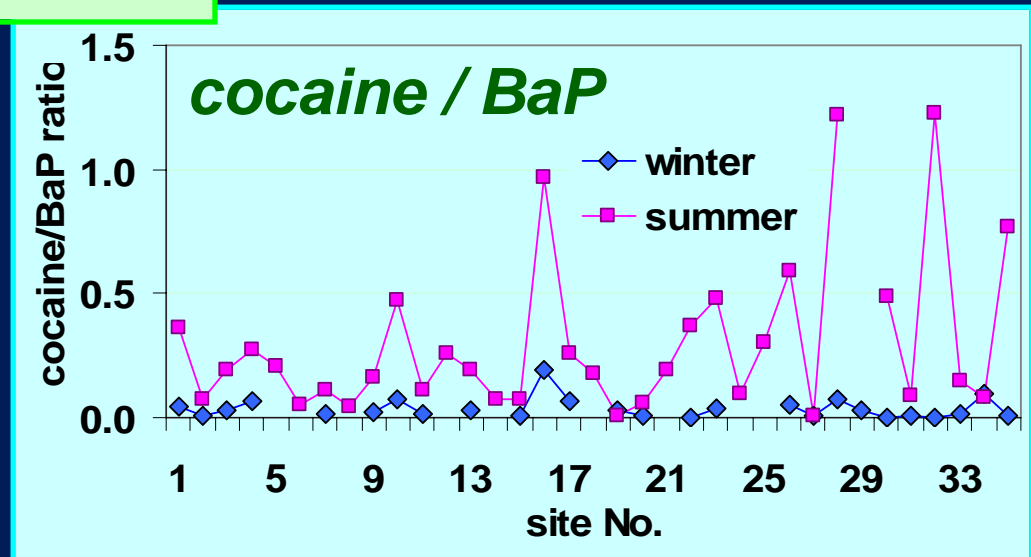
The 2009 Monitoring Campaign of Cocaine in Italy:

some results



Wide differences observed between summer and winter concentrations.

Cocaine can exceed 0.4 ng m⁻³ and its ratio to BaP can exceed 1.0



Probable reasons of the cocaine occurrence in the air:

Drug consume (release through breath, sweat, perspiration, tears and hair)

Drug consume (smoke: crack, hookah)

Drug consume (volatilization, particle dispersion)

Volatilization from surface and waste waters

Combustion of seized hauls and/or hospital refuses

Production and/or refinery (smokes, rejects, wastes)

Drug trafficking (losses)

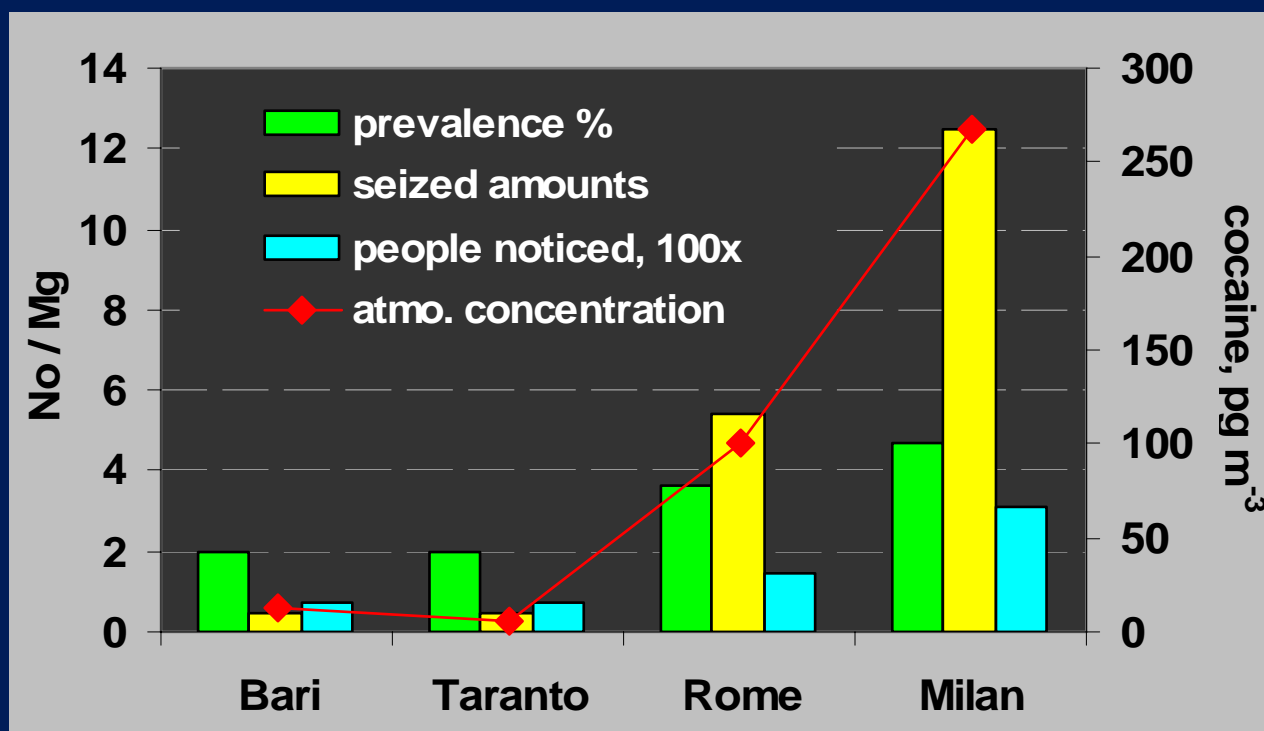


Qualitative relationship between drug seizures, abuse prevalences and average atmospheric concentrations of cocaine

Country	seizures, kg (2006)	abuse preva., % (year)	ave. cocaine ng m⁻³
Italy	4,623	2.1 (2005)	0.09
Serbia & Montenegro	12.9	<i>not available</i>	n.d.
Portugal	34,478	0.3 (2001)	0.15
Algeria	7.8	<i>not available</i>	n.d.
Brazil	14,178	0.7 (2001)	0.17
Chile	6,766	1.8 (2004)	2.8



Tentative proportionality among cocaine contents in the air and social impact indexes of drug abuse at regional scale



Conclusions

- ★ The presence of cocaine and cannabinoids in urban air is consolidated
- ★ Most illicit substances are associated with airborne particles
- ★ The contents of illicit substances in the open atmosphere range between a few picograms to some nanograms per cubic metre
- ★ Both time and site modulations are wide
- ★ Cocaine does not correlate with the principal air pollutants
- ★ The phenomenon seems to be in relationship with the drug abuse
- ★ The “true” or end-point sources of atmospheric psychotropics remain still unknown



We want to thank for the chance You have given us of presenting this speech

For any questions You can contact us at:

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