



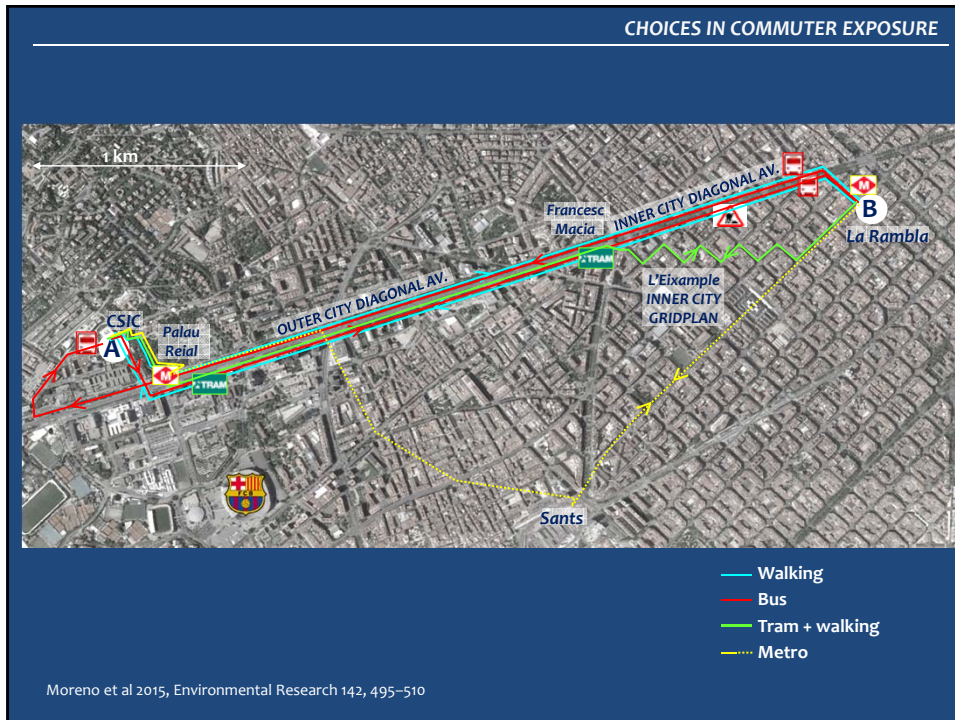
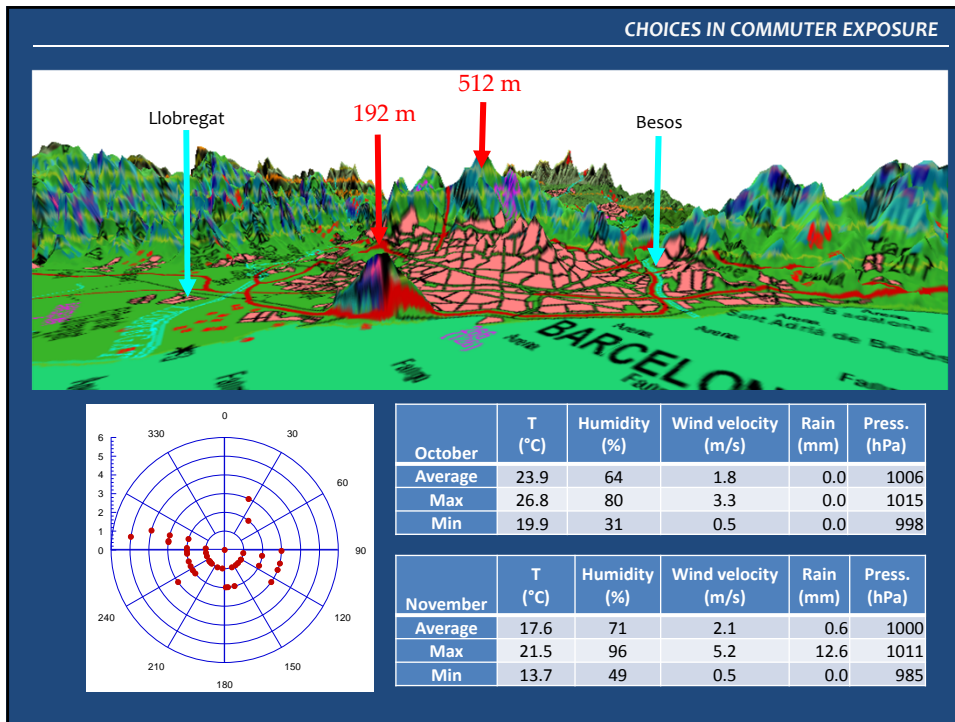
CHOICES IN COMMUTER EXPOSURE TO INHALABLE PARTICULATES

*T. Moreno, C. Reche, I. Rivas, MC. Minguillón, J. Parga,
 V. Martins, M. Pandolfi, M. Brines, M. Ealo, A. Fonseca,
 F. Amato, G. Sosa, W. Gibbons, X. Querol*

*M. Capdevila, E. de Miguel,
 C. Vargas, G. Buonanno*

CHOICES IN COMMUTER EXPOSURE

- We measured urban air quality experienced during travel on different forms of public transport and walking in the city.
- The study continuously tracks and compares not only PM mass and particle number during each journey, but also Black Carbon, Carbon Monoxide, Carbon Dioxide and chemical composition of the finer material inhaled (PM_{2.5}).
- We used continuously measuring portable equipments carried by two commuters making journeys through the city, with the same start and end point, and at the same time but using different transport modes (bus, subway, tram and walking).
- The commuter pairs began their journey together but took different routes through the city. The commute chosen was 8.4 to 9 km long from the suburban area of the *IDAEA-CSIC Institute* to the metro stop on *Rambla de Catalunya* in the city centre.



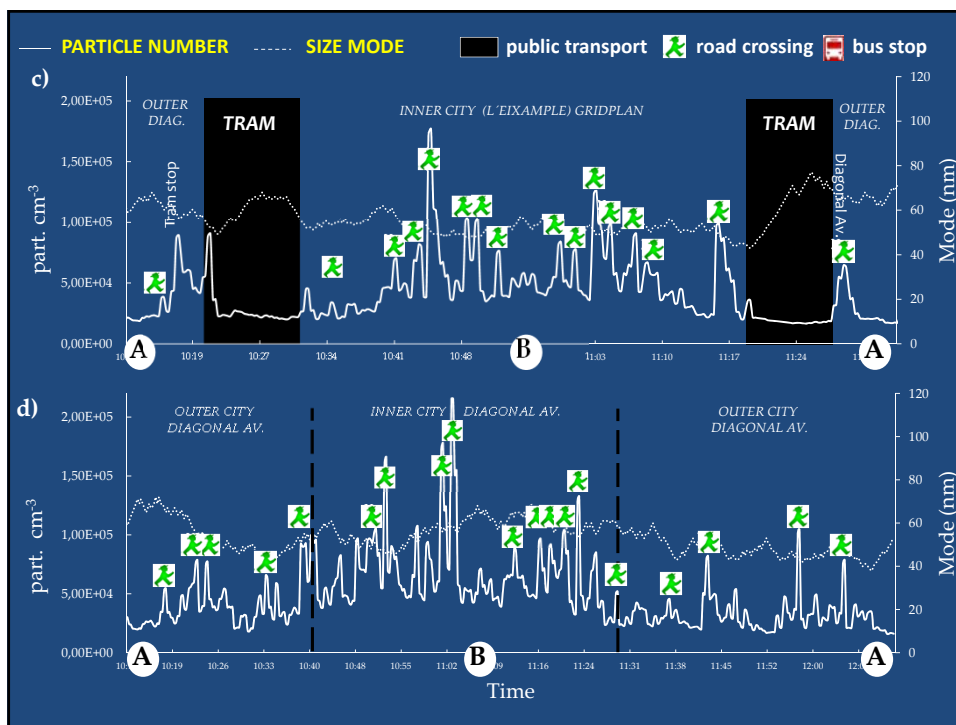
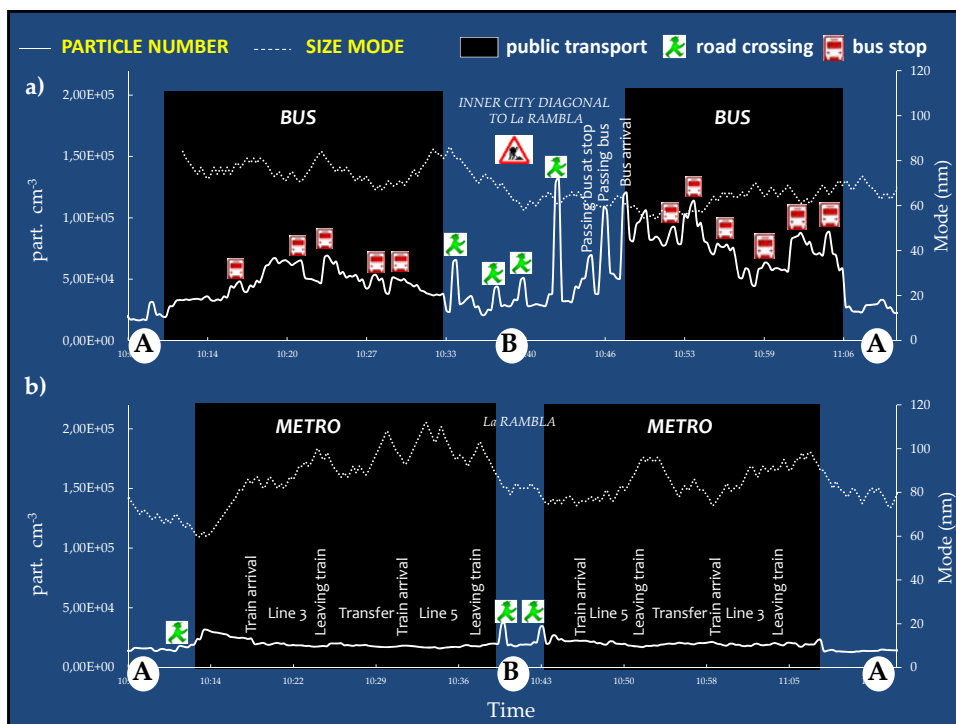


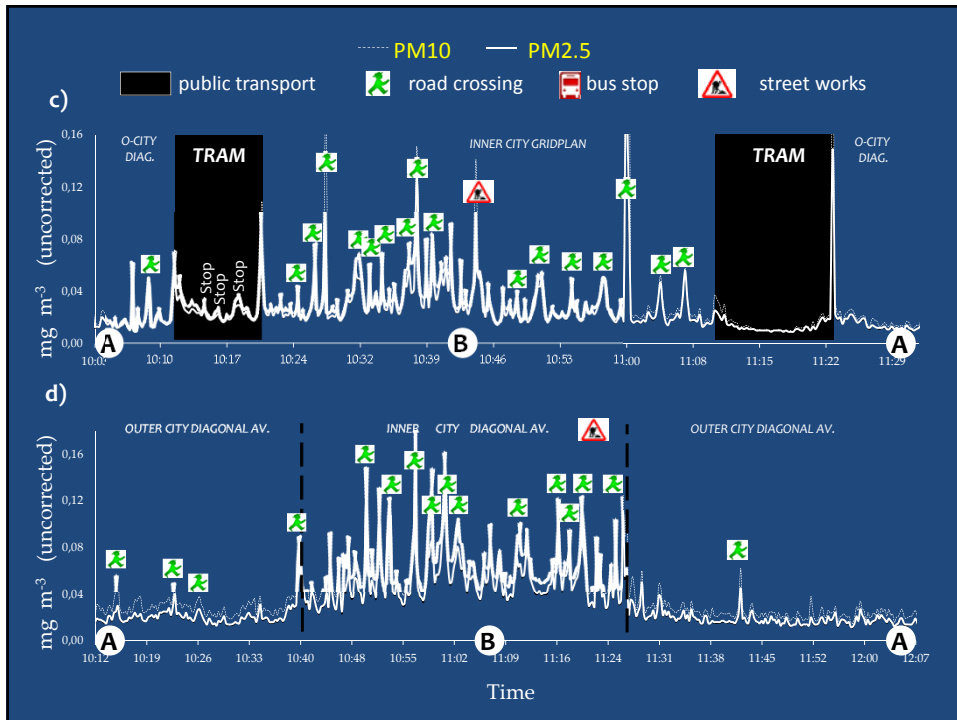
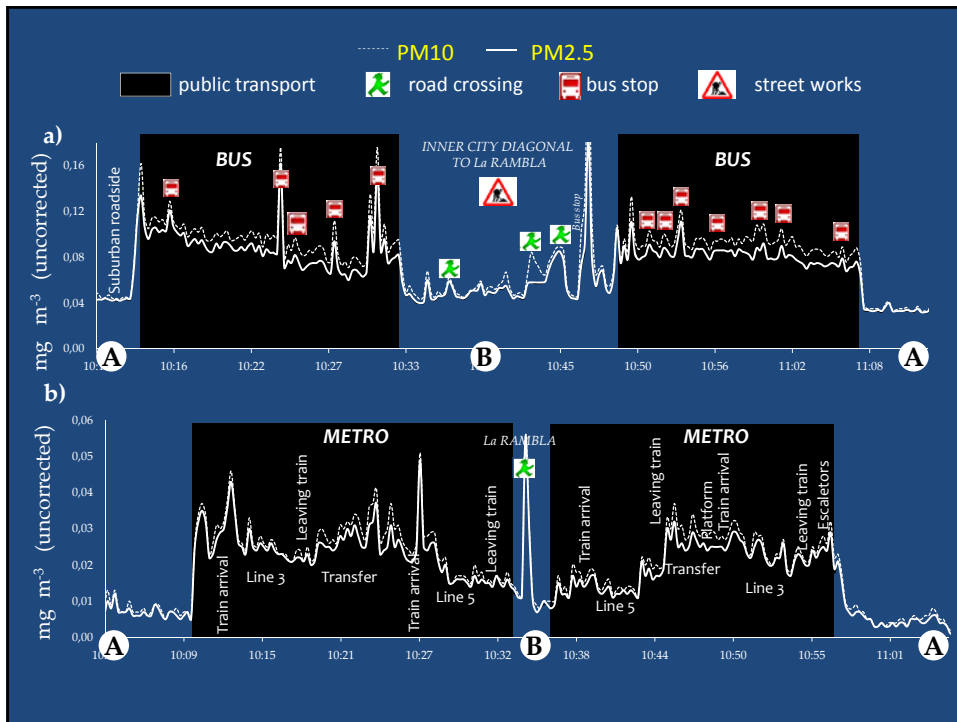
VALUES FOR EACH TYPE OF TRANSPORT

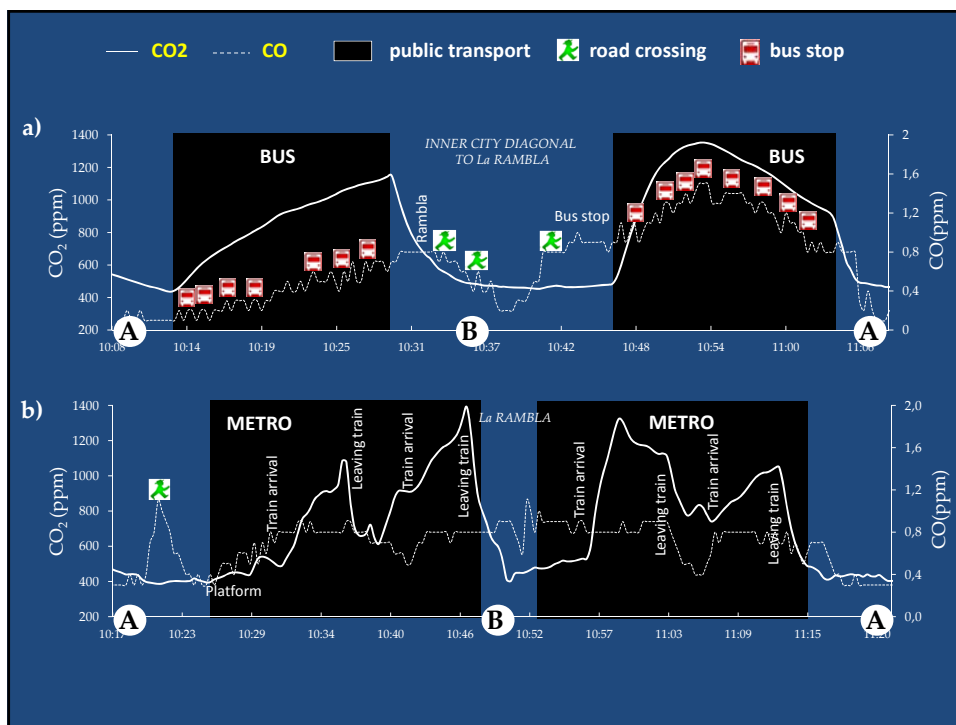
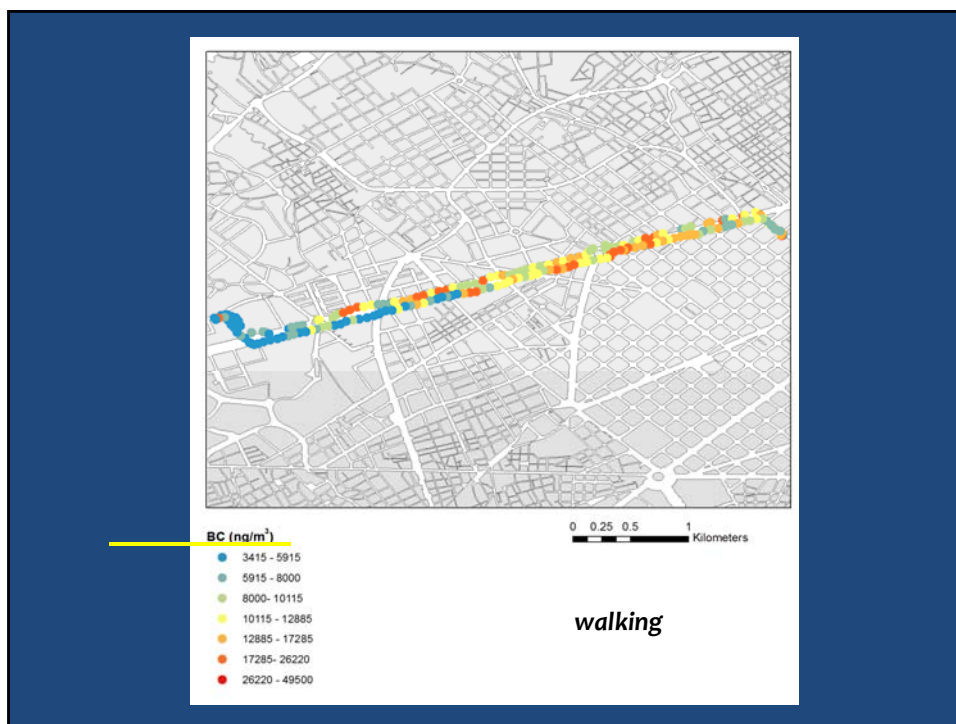
	METRO			TRAM			BUS		
	Mean	St. dev	Median	Mean	St. dev	Median	Mean	St. dev	Median
N (part. cm ⁻³)	2.3 x 10 ⁴	0.4 x 10 ⁴	2.1 x 10 ⁴	3 x 10 ⁴	1 x 10 ⁴	2.8 x 10 ⁴	5.4 x 10⁴	1.6 x 10 ⁴	4.6 x 10 ⁴

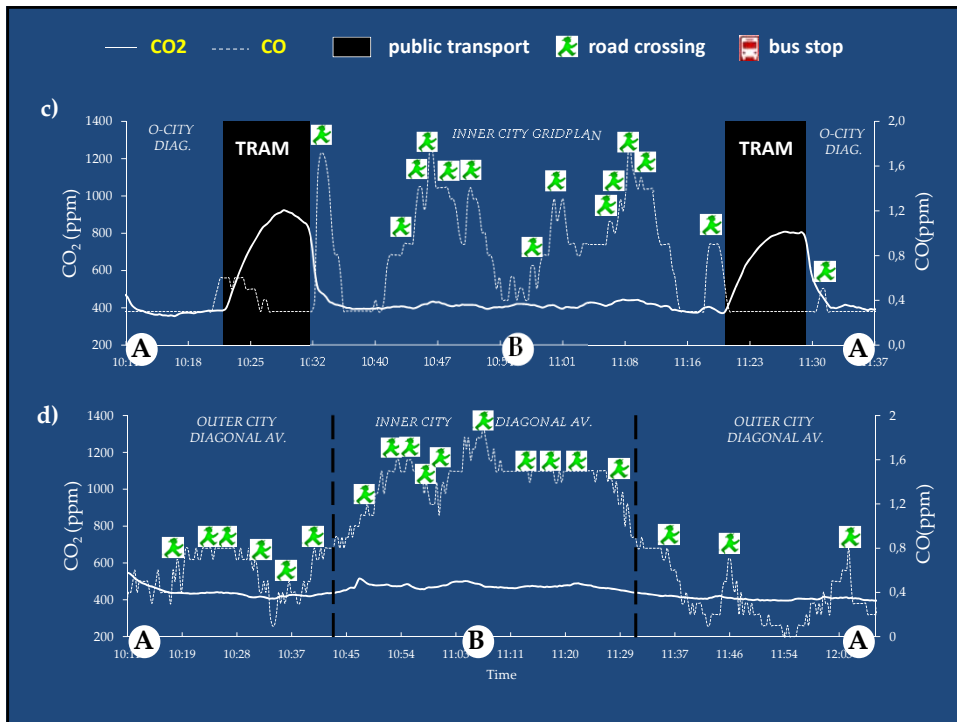
	WALKING											
	OUTER DIAGONAL			INNER DIAGONAL			CENTRAL GRIDPLAN			DIAGONAL TO LA RAMBLA		
	Mean	St. dev	Median	Mean	St. dev	Median	Mean	St. dev	Median	Mean	St. dev	Median
N	3.7 x 10 ⁴	0.6 x 10 ⁴	3 x 10 ⁴	5.9 x 10⁴	1.3 x 10 ⁴	4.8 x 10 ⁴	5.4 x 10⁴	1.8 x 10 ⁴	4.4 x 10 ⁴	5.4 x 10⁴	2 x 10 ⁴	4.2 x 10 ⁴



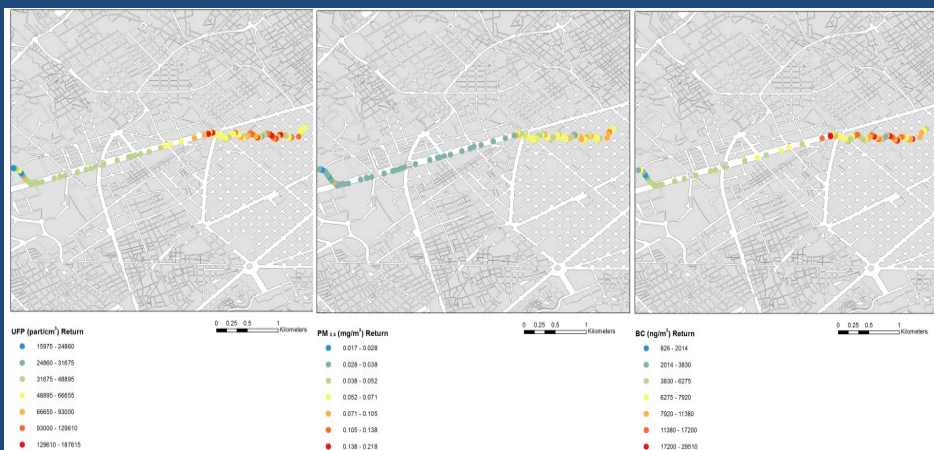








TRAFFIC-RELATED POLLUTANTS



tram + walking

FILTER SAMPLES COLLECTED IN PARALLEL USING FOUR COMMUTING MODES

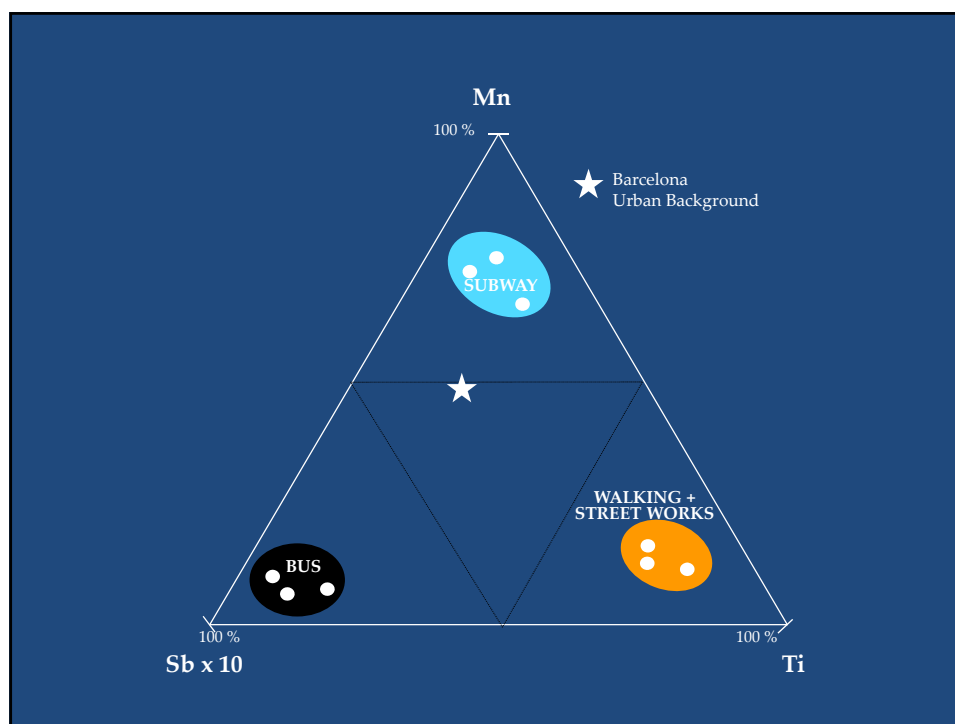
Time period	Transport mode	PM _{2.5}	Transport mode	PM _{2.5}	UB PM _{2.5}
06-14/10/14	Walking	23	Metro	37	12
15-23/10/14	Walking	29	Bus	48	12
24-31/10/14	Walking	32	Tram+Walking	35	17
13-21/11/14	Tram+Walking	27	Metro	49	12
24/11-2/12/14	Metro	42	Bus	49	11
05-12/11/14	Tram+Walking	29	Bus	39	10

UB: Urban Background Site

PM2.5 CHEMISTRY

Date	AVERAGE (3 filters)			
	Walking	Metro	Tram + walking	Bus
PM _{2.5}	27.8	42.6	30.6	45.2
Al ₂ O ₃	1.2	0.2	0.01	0.2
Ca	1.8	1.1	0.6	1.2
Fe	1.1	13.3	0.7	2.2
K	0.5	0.7	0.9	0.6
Na	0.4	0.3	0.2	0.3
Mg	0.3	0.3	0.1	0.2
P	0.04	0.03	0.03	0.06
S	1.1	0.7	0.6	0.6

Date	AVERAGE			
	Walking	Metro	Tram + walking	Bus
ng m ⁻³				
Ti	106.5	27.1	14.3	34.6
V	8.9	4.7	3.5	7.7
Mn	18.4	120.3	14.2	23.7
Co	0.7	1.5	0.3	< dl
Cu	36.2	112.0	24.9	170.6
Zn	101.6	179.8	53.0	130.2
As	2.0	1.0	0.5	1.9
Rb	0.9	1.1	< dl	1.1
Sr	5.2	14.3	2.9	4.2
Zr	7.7	13.3	< dl	32.4
Cd	0.2	0.1	0.3	< dl
Sn	5.8	5.4	3.9	5.7
Sb	2.0	2.5	0.7	24.1
Ba	23.1	494.6	19.8	59.9
La	0.5	0.4	0.5	0.5
Ce	1.2	0.9	0.6	1.1
Nd	0.3	0.2	< dl	0.2
Sm	0.7	1.1	0.9	1.0
Pb	8.8	7.5	6.6	7.1
U	0.9	1.0	1.2	1.4



SCIENTIFIC SUMMARY

- The average N were lowest in subway trains ($< 2.5 \times 10^4$) and highest in diesel bus or walking in the city centre trafficked streets ($> 5.0 \times 10^4$). Pedestrians at busy traffic crossings are exposed to transient peaks reaching $> 10^6$.
- Subway particles display a size mode larger (90 nm) than in outdoor commuting environments (< 70 nm).
- Regarding $PM_{2.5}$ and BC, commuting using the tram appears to be consistently the cleanest form of city public transport when compared to both bus and subway.
- CO concentrations (like BC) are good proxies for traffic contamination, whereas CO_2 concentrations are an indicator of the number of indoor passengers on public transport.
- Urban roadside pedestrians can inhale more siliceous “crustal” dust, whereas subway passengers inhale a more obviously anthropogenic PM mix enhanced in Fe, Mn, Zn, Sr and Ba. Bus air registered unusually high levels of Sb and Cu, probably contaminated mainly from the bus itself.

Moreno et al 2015, Environmental Research 142, 495–510

TAKE HOME MESSAGE

- When we commute through the city the air pollutants we breathe vary greatly in concentration, number, size and chemical composition, depending on the route and transport chosen.
- The kinds of data presented here using mobile equipment offer the urban traveller better informed choices to help minimise exposure to air pollution during the daily commute.

teresa.moreno@idaea.csic.es

