A European aerosol phenomenology -4:

carbonaceous aerosol sampling artifacts, analytical discrepancies, and hamonised concentrations at 10 regional background sites across Europe

A result of the EUSAAR + ACTRIS activities

Status:

- **Draft "0" circulated before summer**
- **Deadline for comments: 31 Aug. 2015**
  - **Comments from BIR, HRL, KPS, MEL, MHD, MSY, PUY**
- **Draft 1 to be completed by the end of Nov. 2015**

Sites

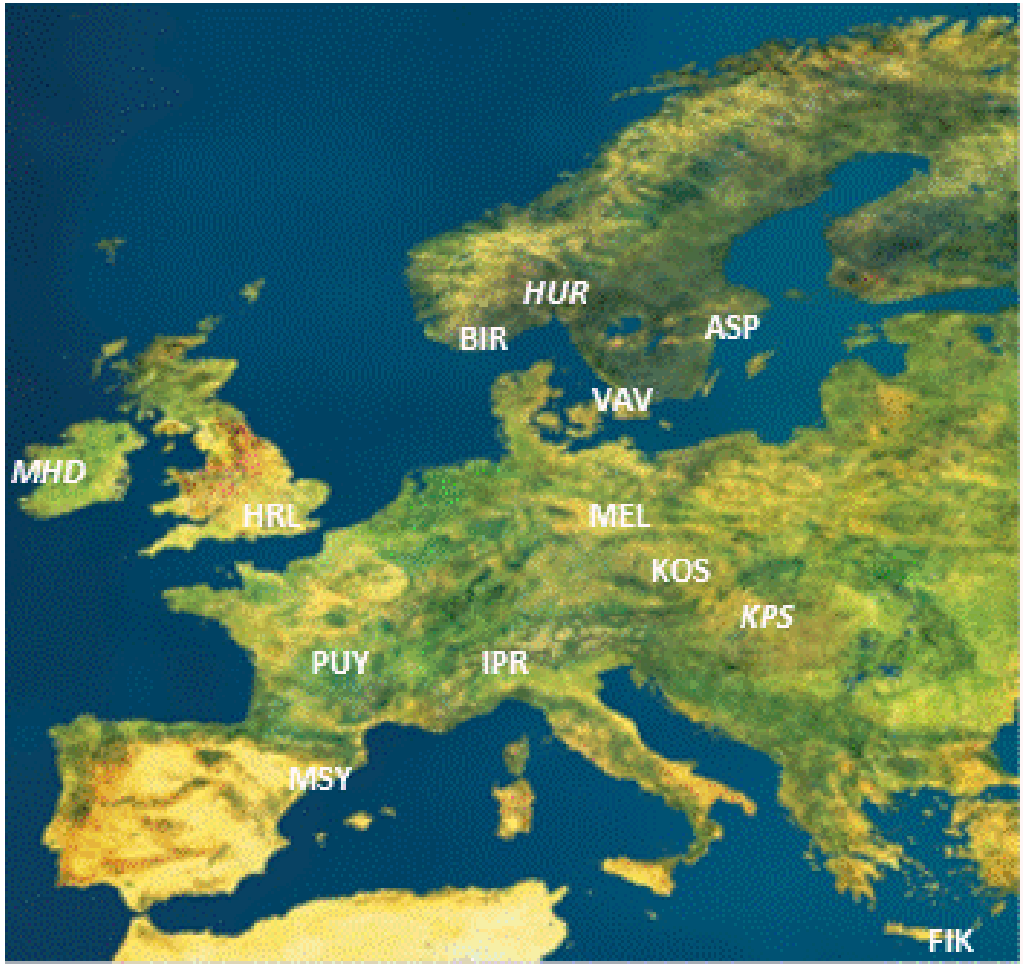


Fig. 1: observatories from which data are presented.
Sites in italics were used for studying sampling artifacts only.
Photo: ESA, 2003.

Analytical discrepancies: no correction for TC

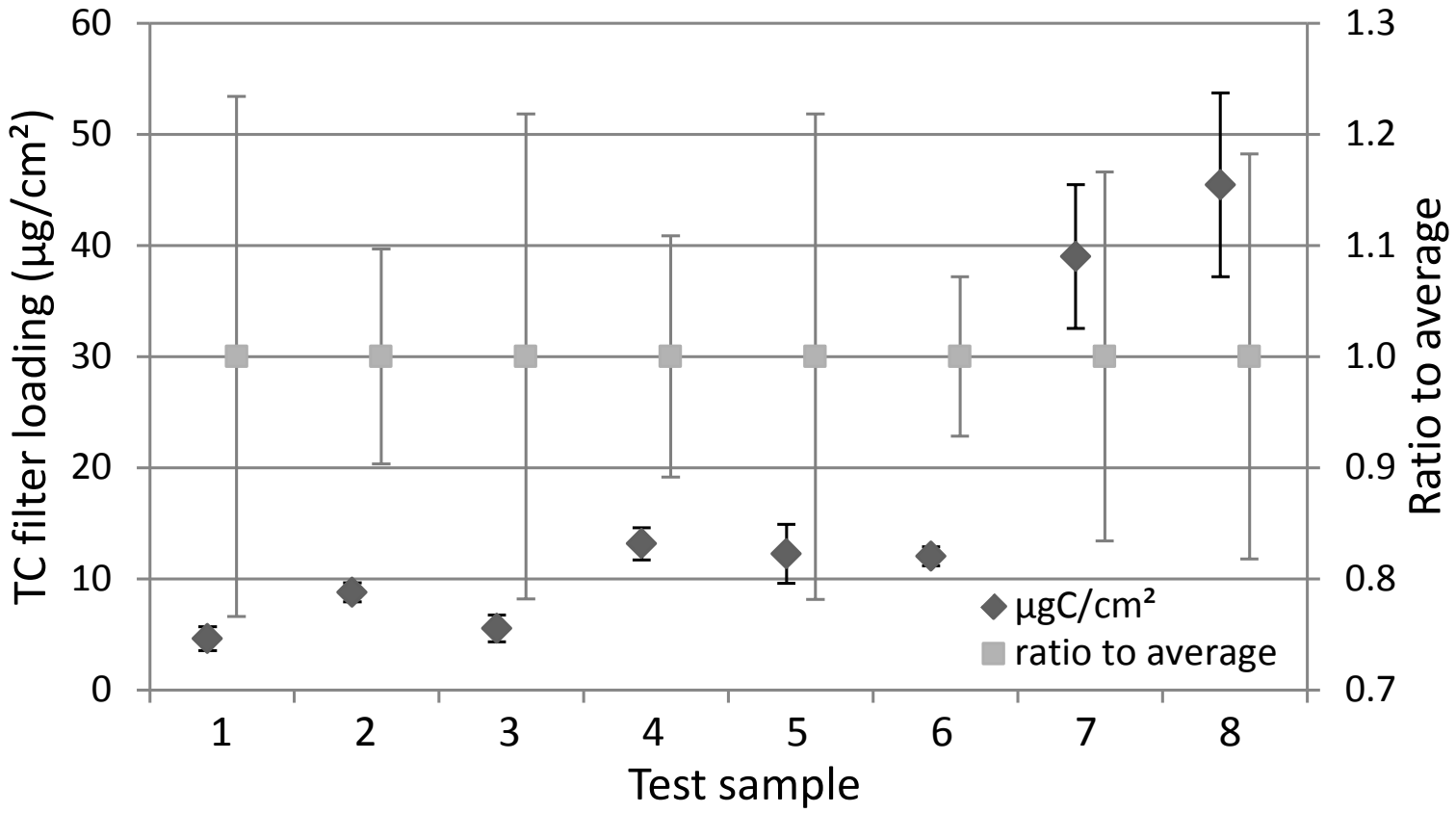


Fig. 2: range of concentrations and ratio to the reference value for TC concentrations reported for 8 tests samples by the 13 participants in the ACTRIS inter-laboratory comparison 2008. Error bars show 1 standard deviation.

Analytical discrepancies: correction applied for EC/TC

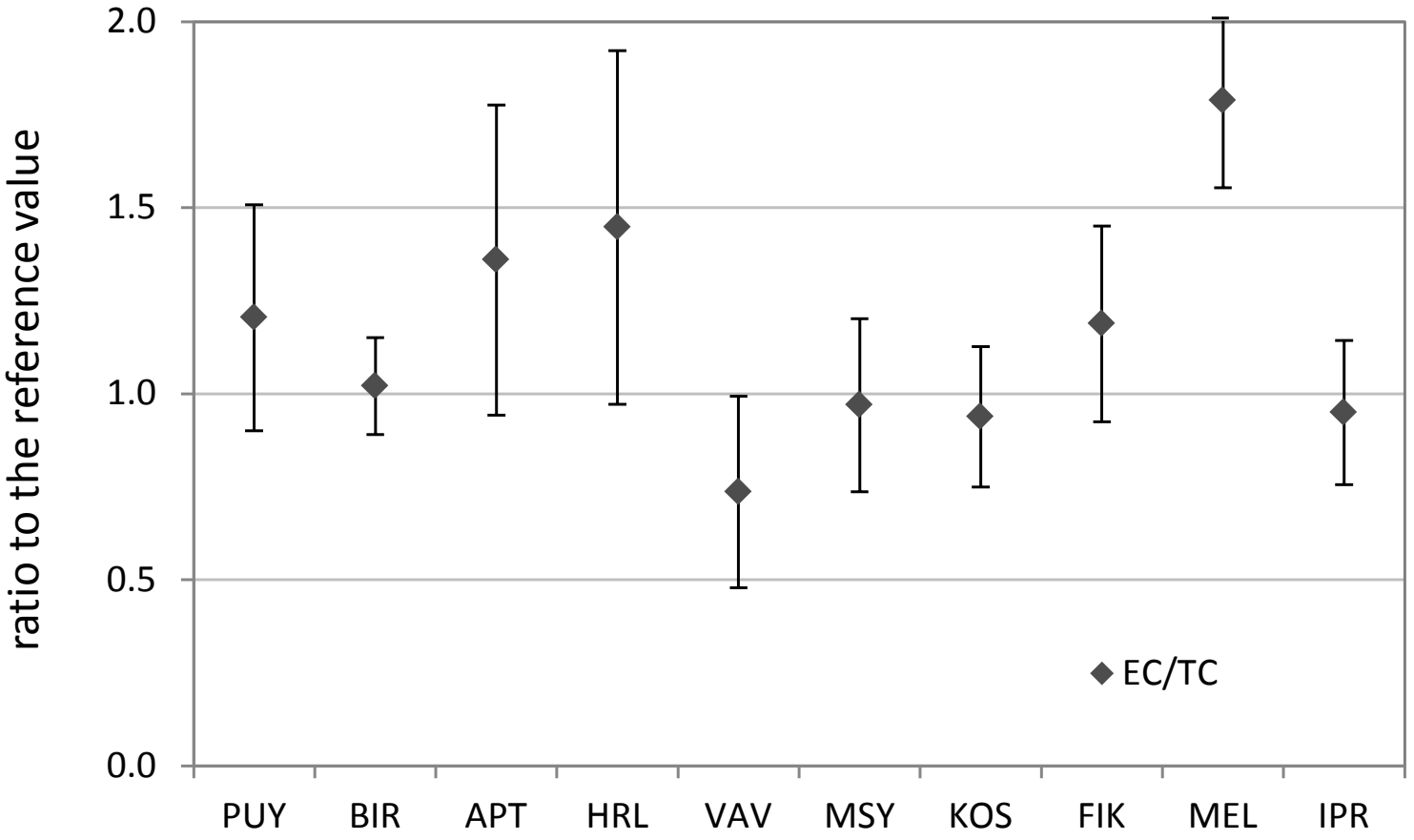


Fig. 3: average ratio to the reference value of the EC/TC ratio reported by the participants in the inter-laboratory comparisons performed in 2008, 2009 and 2011. The reference value is the robust average among participants using the EUSAAR-2 analytical protocol. Error bars represent 1 standard deviation.

Sampling artifacts

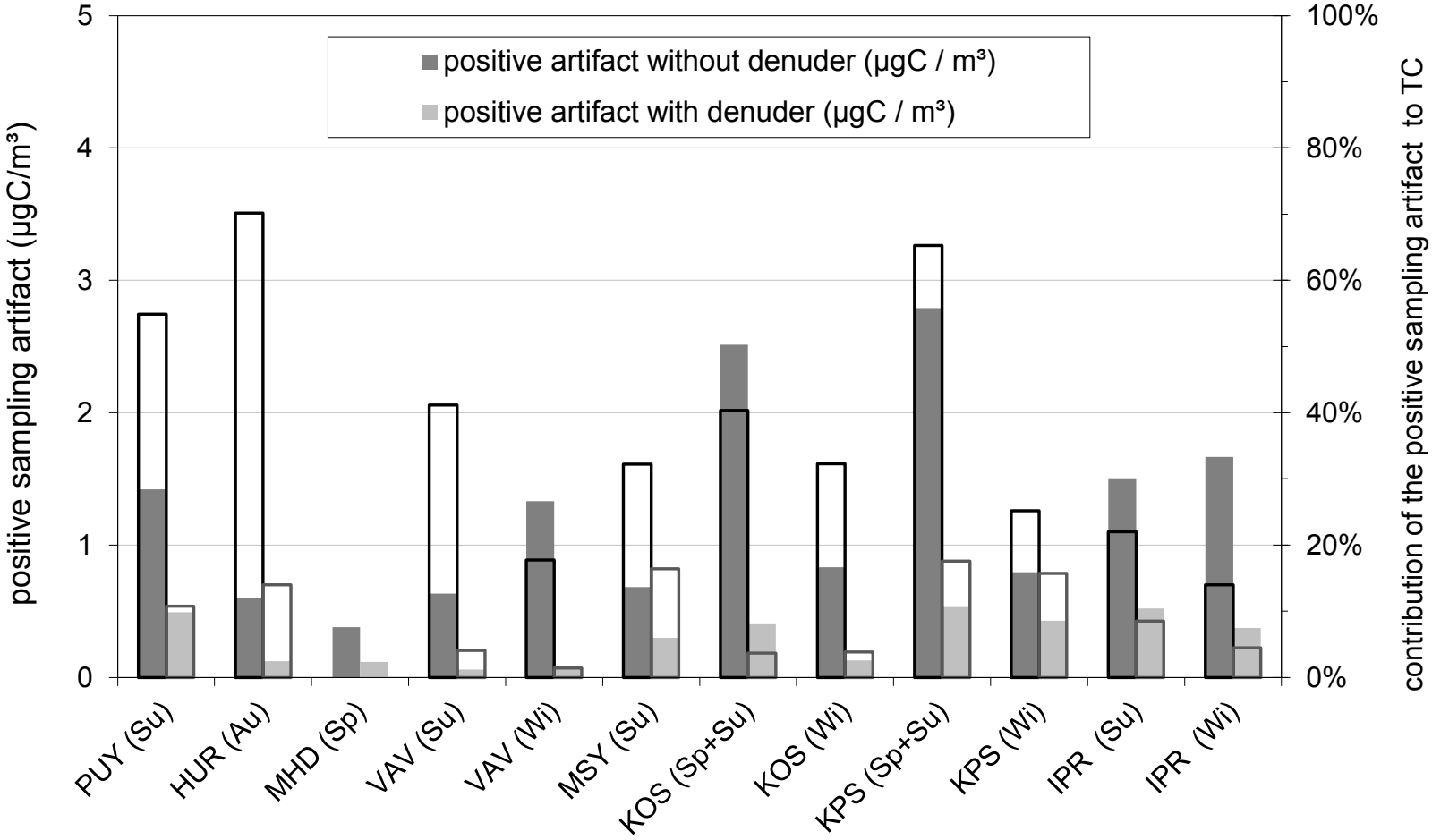


Fig. 5: seasonal average positive sampling artifacts observed at 8 regional background sites across Europe. Solid bars show artifacts in µg m^{-3} (left hand scale), and open bars the contribution of artifacts (%) to the amount of TC collected by a bare quartz fiber filter (right hand scale).

Sampling artifacts

Table 2. OC positive sampling artifacts, denuder efficiency, and remaining OC positive sampling artifacts when using a denuder

		positive artifact without denuder			denuder efficiency		positive artifact with denuder		
		average	contribution to total OC		average	st. dev.	average	contribution to total OC	
		µgC / m³	mean	std. dev.			µgC / m³	mean	std. dev.
PUY	Su	1.42	55%	26%	72%	22%	0.49	13%	10%
HUR	Au	0.60	70%	35%	73%	22%	0.12	14%	7%
MHD	Sp	0.38	ND	ND	68%	34%	0.12	ND	ND
VAV	Su	0.63	41%	14%	90%	2%	0.06	4%	2%
	Wi	1.33	18%	4%	93%	3%	0.08	1%	0%
MSY	Su	0.68	32%	16%	54%	26%	0.30	16%	14%
KOS	Sp+Su	2.51	40%	9%	90%	6%	0.41	4%	2%
	Wi	0.83	32%	7%	84%	13%	0.13	4%	3%
KPS	Sp+Su	2.79	65%	21%	84%	5%	0.54	18%	22%
	Wi	0.79	25%	4%	43%	30%	0.43	16%	11%
IPR	Su	1.51	22%	7%	62%	21%	0.52	8%	7%
	Wi	1.67	14%	4%	78%	9%	0.37	5%	2%

=> Denuder warmly recommended

Denuder: particle penetration

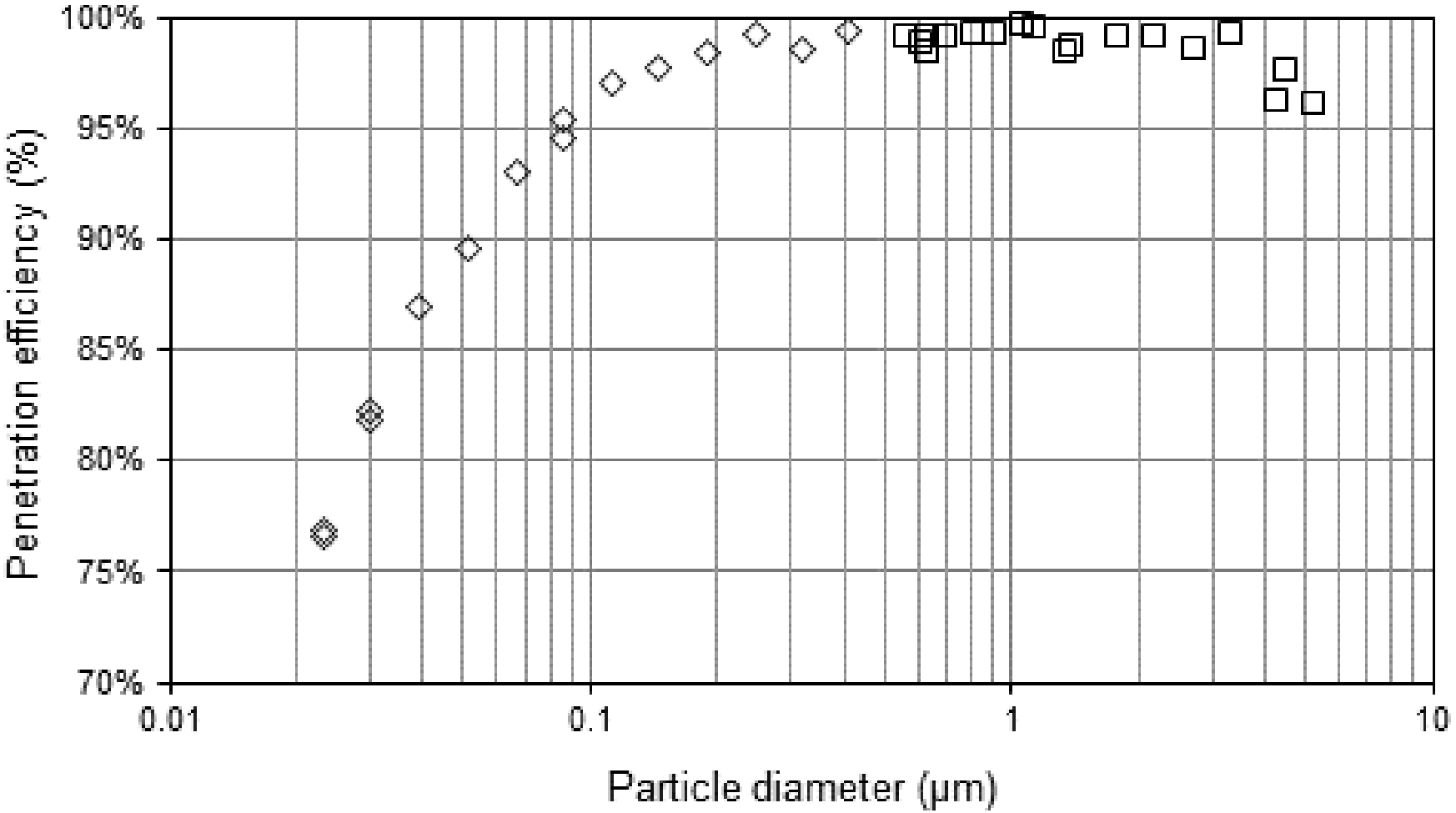


Fig. 6: penetration of particles in a 20 cm long C-monolith denuder measured with a Differential Mobility Particle Sizer (diamonds) and an Aerodynamic Particle Sizer (squares).

Denuder: impact on negative artifact

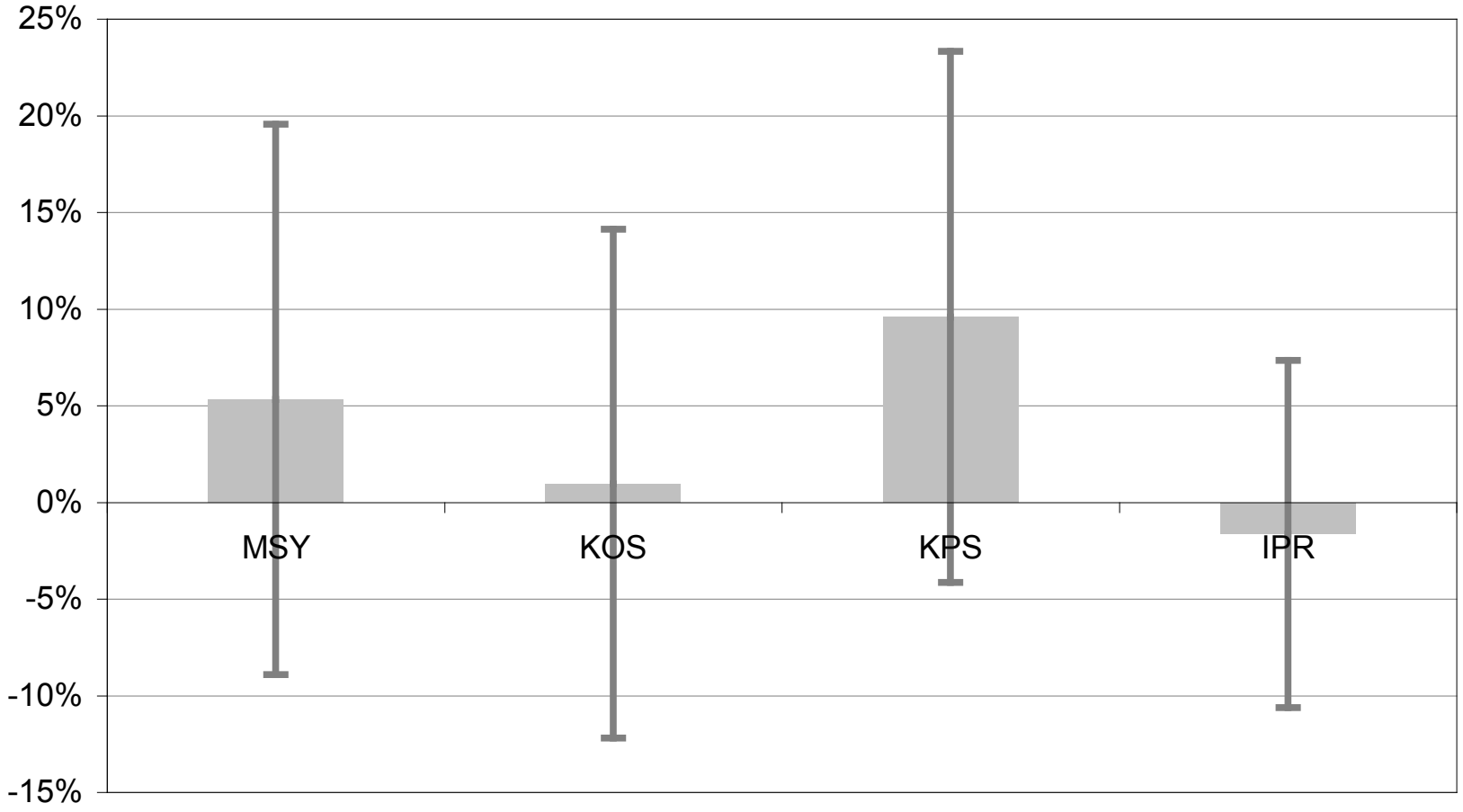


Fig. 7: negative sampling artifact induced by the EUSAAR denuder (average and standard deviation of 8 – 15 experiments performed at each site). Negative values represent losses.

Data availability

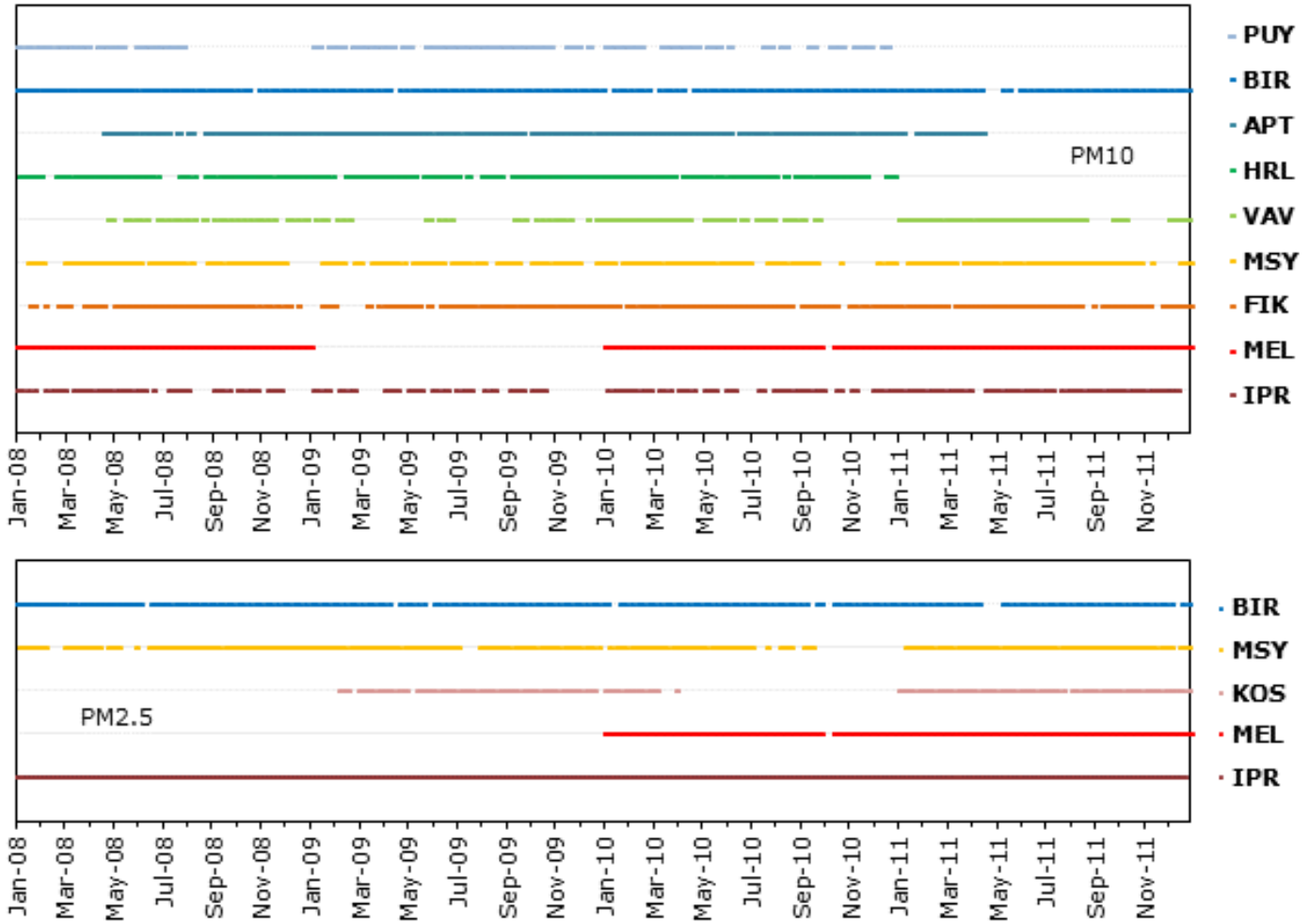


Fig. 8: temporal coverage for the carbonaceous species

PM mass concentration

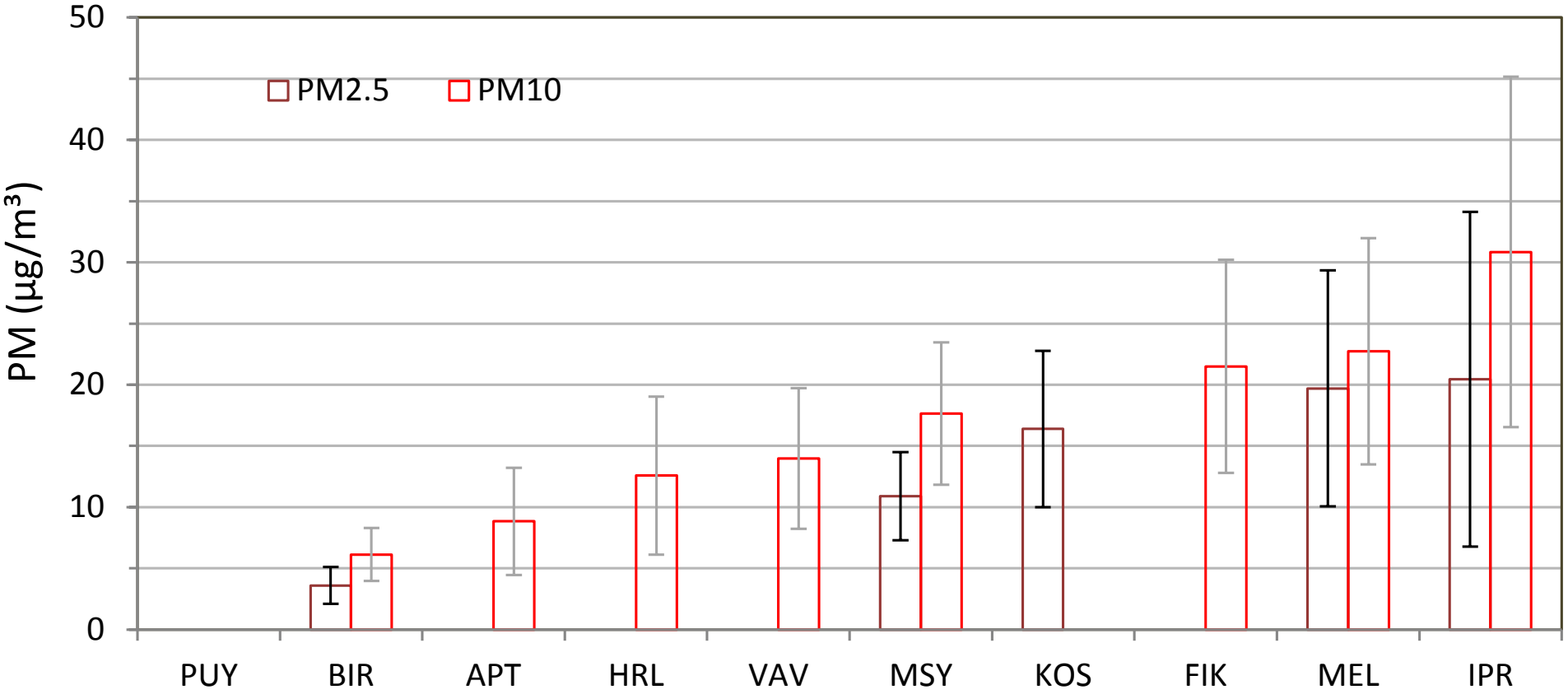


Fig. 9: average PM10 and PM2.5 mass concentrations at 10 sites across Europe. No PM mass concentrations are from PUY.
Error bars show one mean absolute deviation around averages.

TC concentration

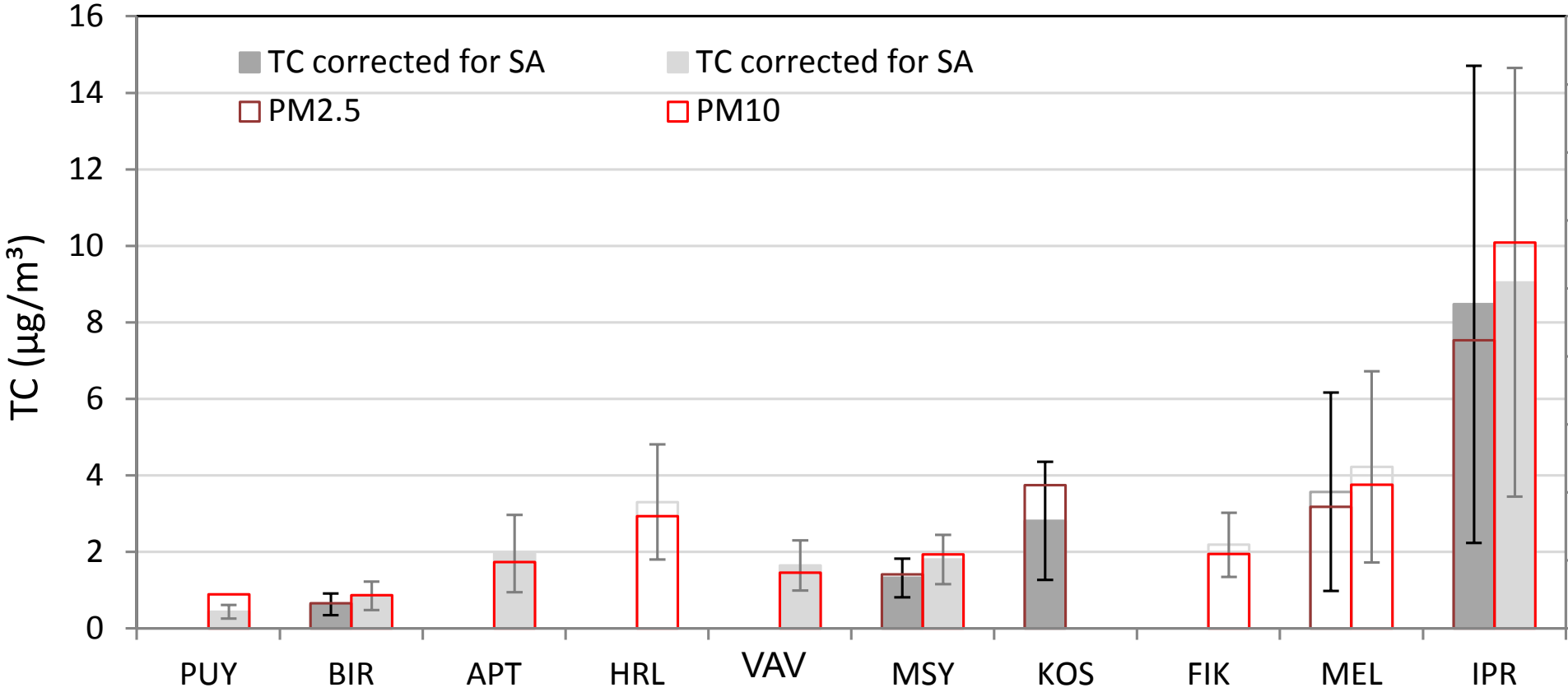


Fig. 10: average concentrations of TC in PM2.5 and PM10.
Open bars represent the raw data obtained at the stations, and full bars the concentrations corrected for sampling artifacts and analytical biases.
Error bars show one mean absolute deviation around corrected averages.

EC concentration

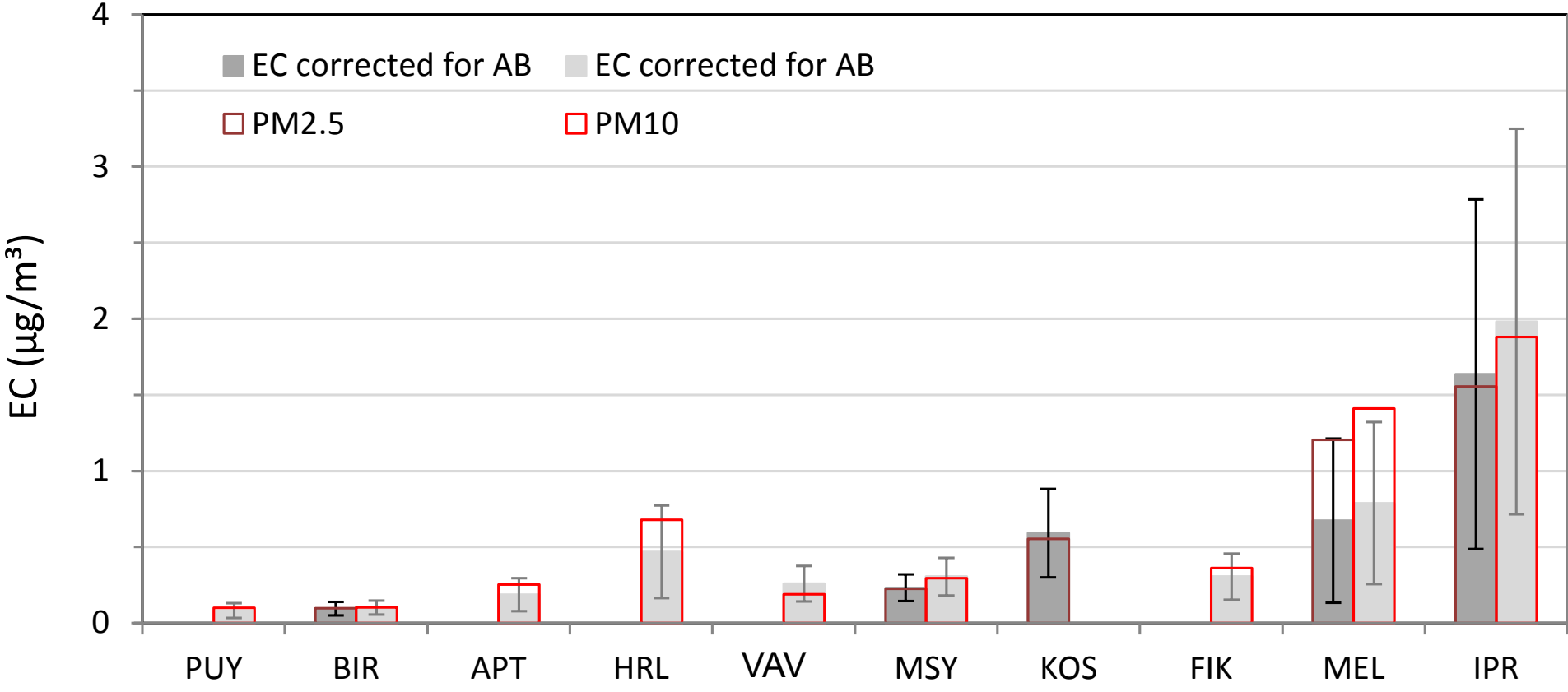


Fig. 10b: average concentrations of EC in PM2.5 and PM10.
Open bars represent the raw data obtained at the stations, and full bars the concentrations corrected for sampling artifacts and analytical biases.
Error bars show one mean absolute deviation around corrected averages.

PM composition

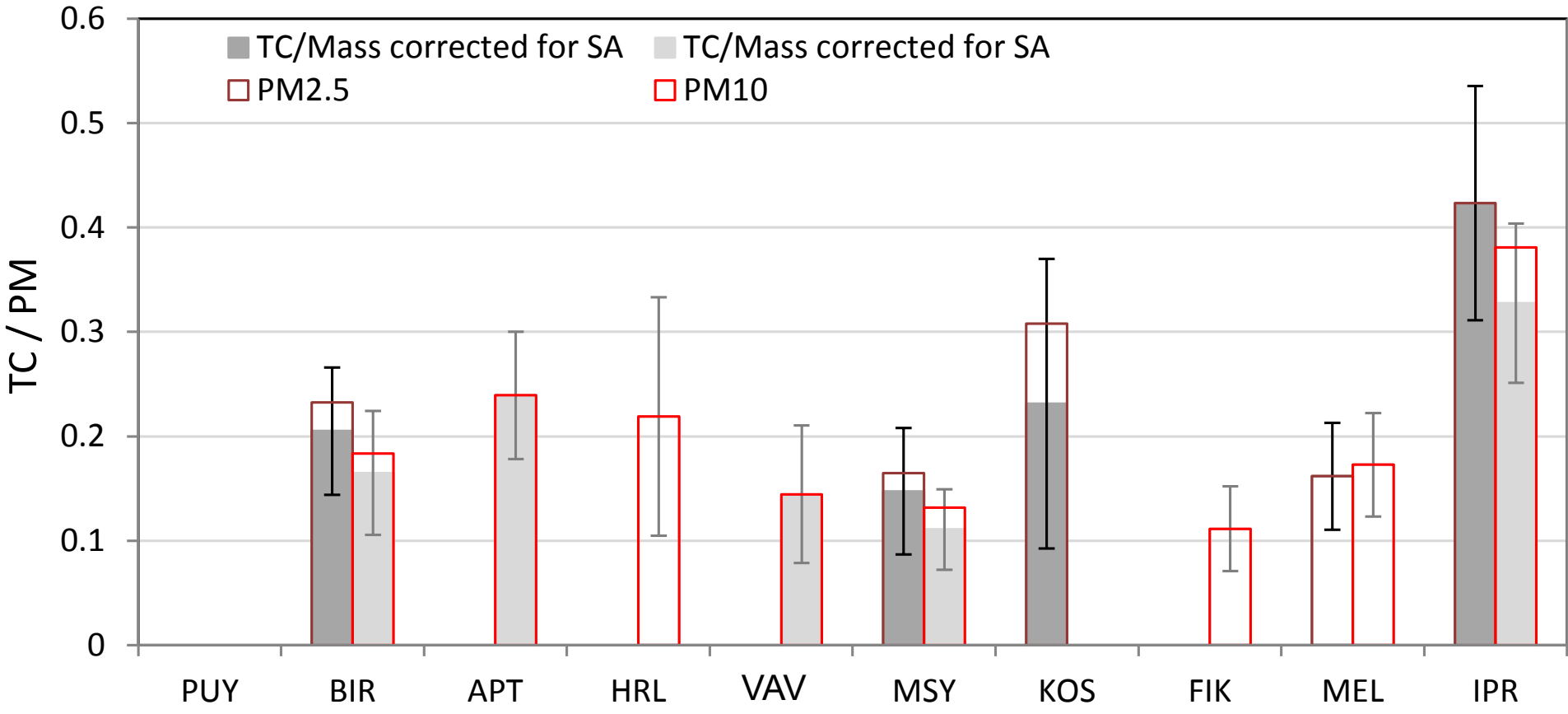


Fig. 11: average TC/ PM ratios in PM2.5 and PM10. Open bars represent the raw data obtained at the stations, and full bars the values corrected for sampling artifacts. Error bars show one mean absolute deviation around corrected averages.

PM composition

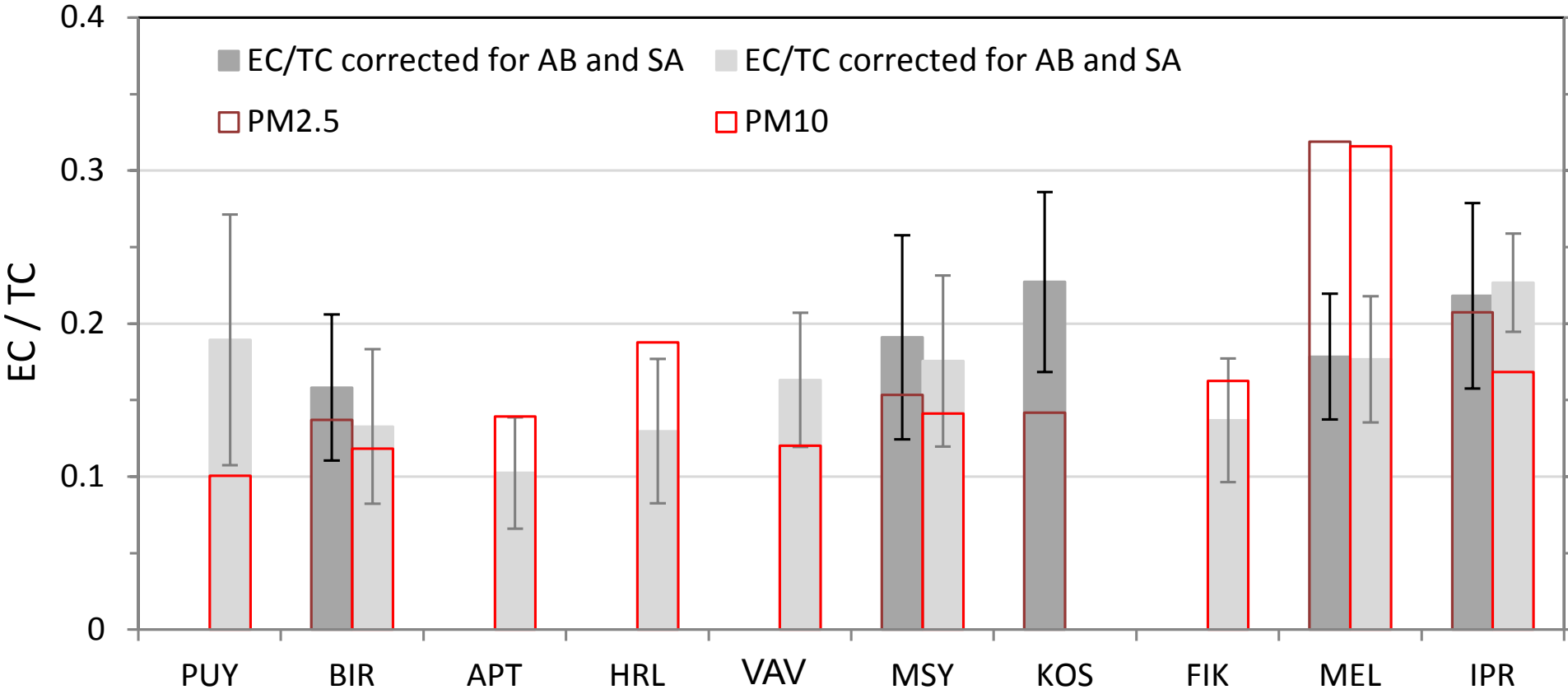


Fig. 12: average EC/ TC ratios in PM2.5 and PM10.
Open bars represent the raw data obtained at the stations,
and full bars the values corrected for sampling artifacts and analytical biases.
Error bars show one mean absolute deviation around corrected averages.

Seasonal variations

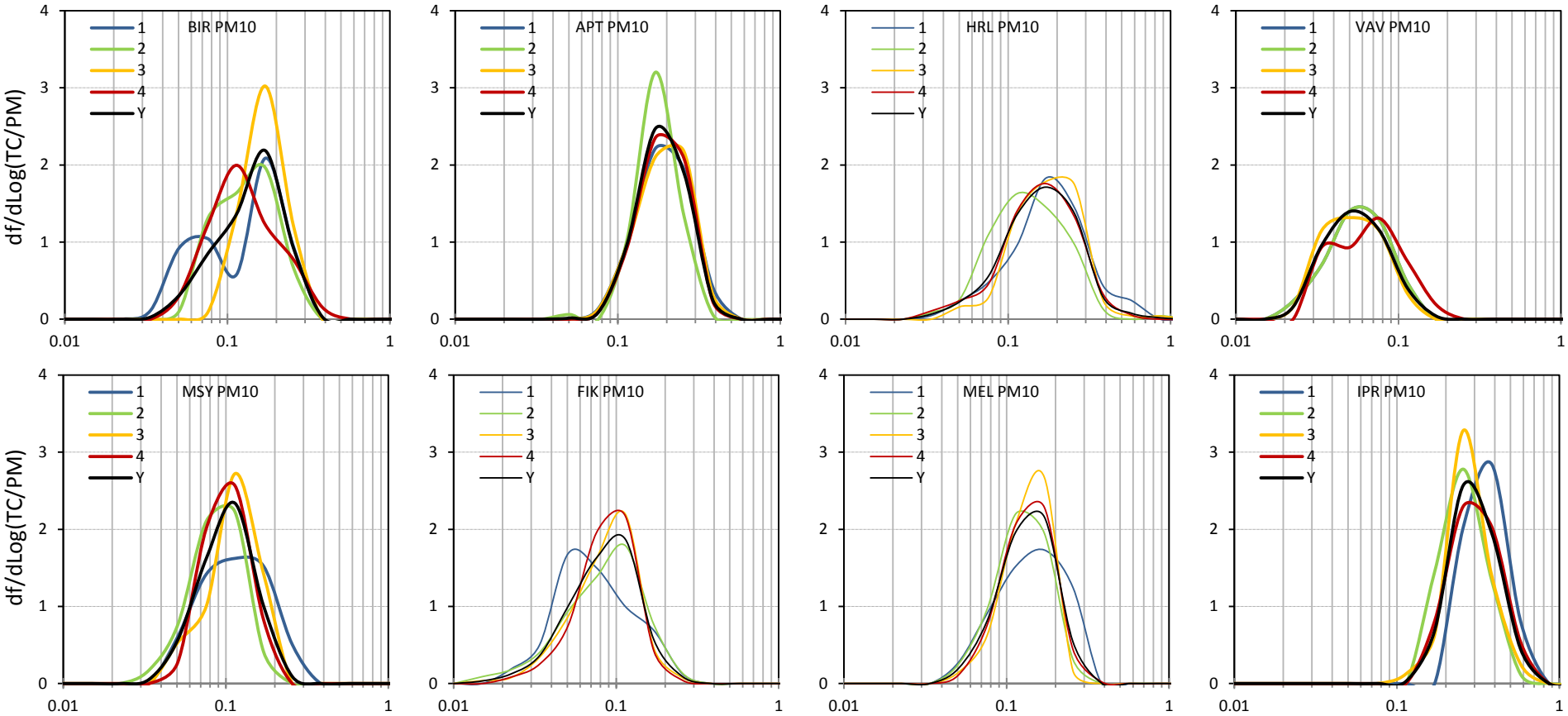
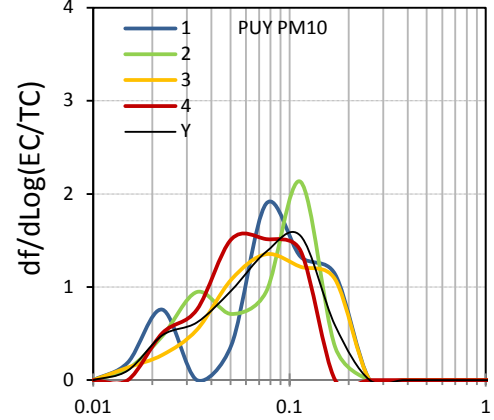
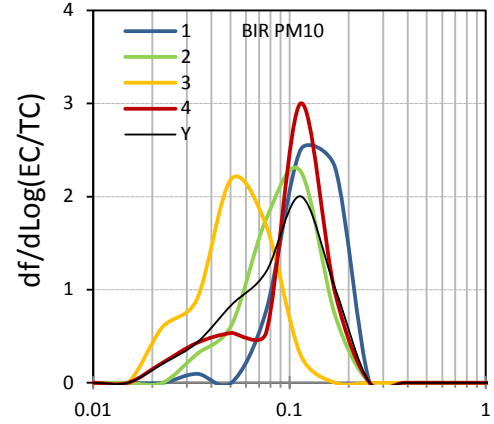
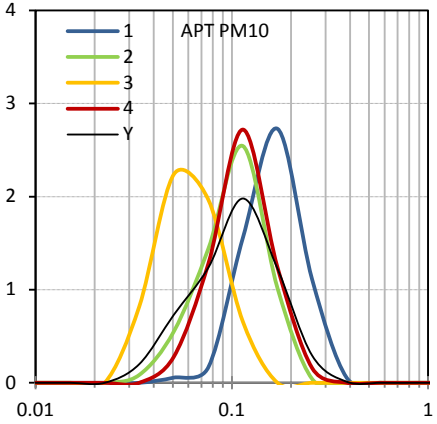


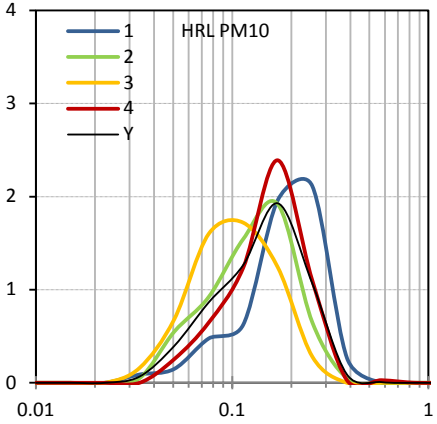
Fig. 13a: seasonal and annual (Y) mean frequency distribution of the ratio TC/PM10 (1=DJF, 2=MAM, 3=JJA, 4=SON). Thin lines represent distributions at sites where positive sampling artifacts were not addressed.

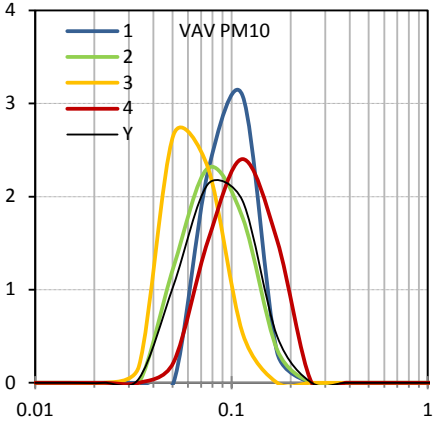
Seasonal variations (cont'd)

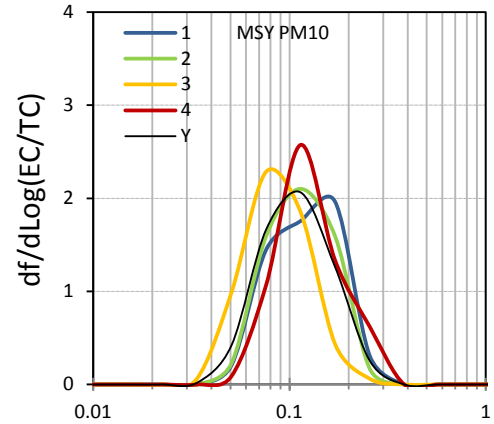


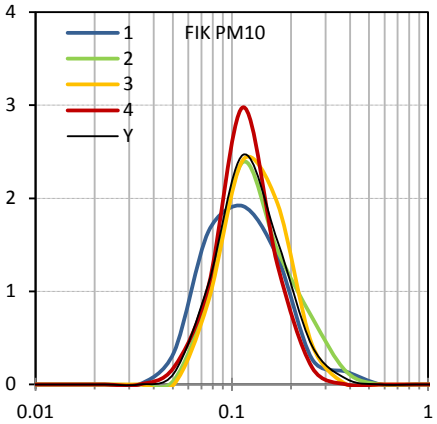


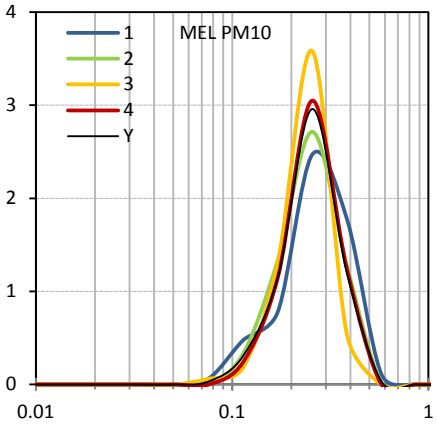


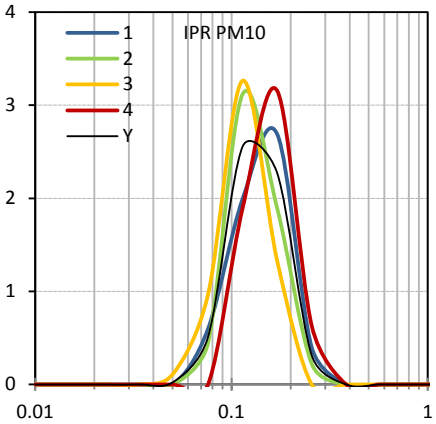












Seasonal variations

Fig. 15: seasonal variations in (b) TC/PM and (c) EC/TC ratios. Lines without full symbols correspond to the sites for which sampling artifacts were not addressed.

Conclusions

• Robust assessment of the carbonaceous aerosol concentration, composition and contribution to PM10 and PM2.5 at the time where the European Directive 2008/50/EC entered into force.

• Unlike our previous “phenomenologies”, this one results from a coordinated action aiming at producing comparable TC, OC and EC data.

➢ The comparability of the analysers used across the network was assessed, and the systematic differences in the OC/EC split we observed were used to normalize the data provided by different laboratories.

➢ Positive sampling artifacts for OC were estimated at most sites. They are not negligible (site dependent average ranging 14 – 70%), but still difficult to determine accurately and highly variable.

=> A denuder was tested and validated. Its implementation is recommended for more accurate determination of particulate OC concentrations.

• At several sites, the ratio TC/PM is highest during winter months, when exceedances of particulate pollution daily limits occur. In contrast, EC/TC ratios are quite similar in winter (0.22 ± 0.03) at all the sites of this study, except in Crete (0.10).