Optical and thermal measurements and source apportionment of TC, BC, OC, EC and CM with high time resolution

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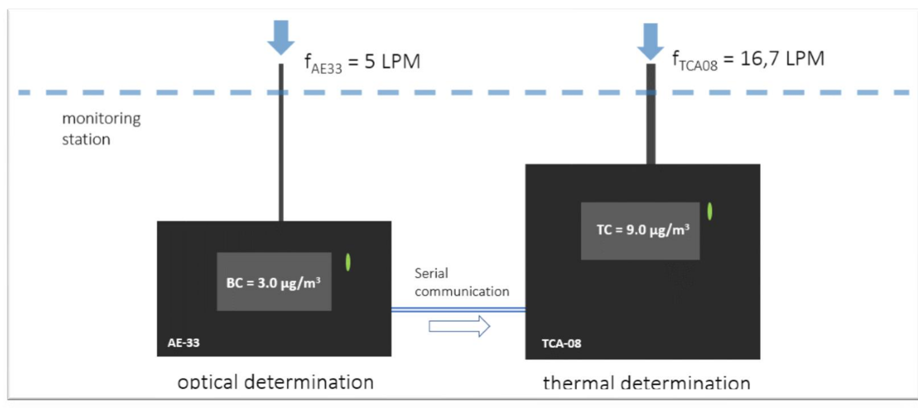
NEW METHOD

We present newly developed TC-BC method, which combines an optical method for measuring black carbon (BC) by the Aethalometer AE33, and a thermal method for total carbon (TC) determination by the Total Carbon Analyzer TCA08 which can be used to apportion sources of carbonaceous aerosols in real time with high time resolution. TC-BC method determines organic carbon (OC) fraction of carbonaceous aerosols as:

$$OC = TC - b \cdot BC\,,$$

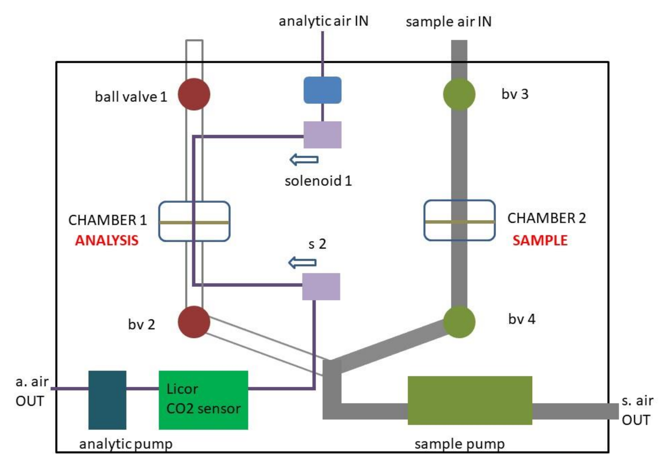
where b·BC is equivalent to elemental carbon (EC) and the determined proportionality parameter b is region/site specific but also depends to a large extent on a thermal protocol used to determine the EC fraction with the conventional OC/EC method.

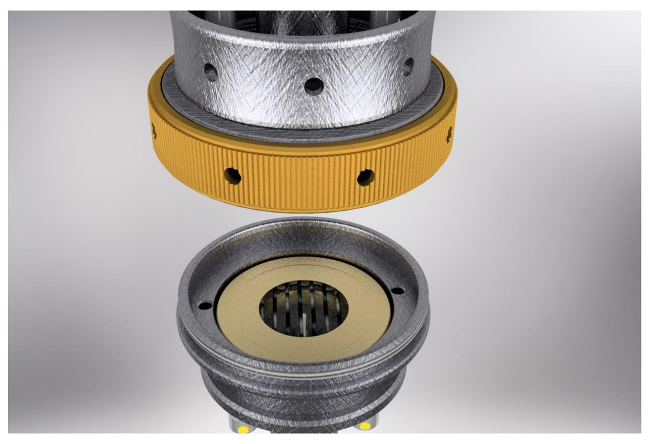


TOTAL CARBON ANALYZER

The TCA-08 Total Carbon Analyzer instrument uses a thermal method for total carbon (TC) determination. The instrument has two parallel flow channels with two chambers, which can be used either for sampling either for thermal analysis. While one channel is collecting its sample for the next time-base period, the other channel is analyzing the sample collected during the previous period.

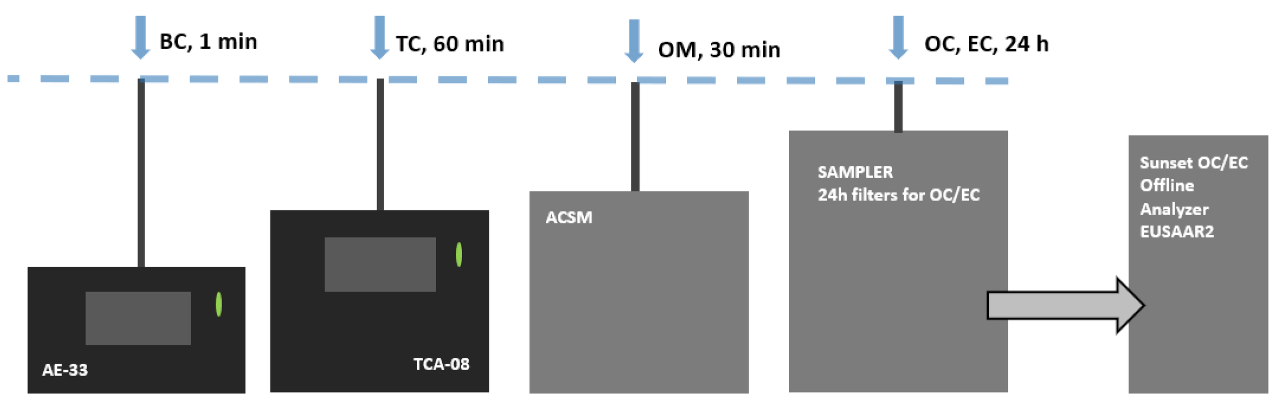
After collection on the filter, heating modules, that consist of housing and nickel-chrome wire, above and under the quartz filter heat the sample almost instantaneously in a small flow of filtered ambient air. This produces almost complete combustion of all carbonaceous compounds into CO_2, which creates a short-duration, but large-amplitude pulse of CO_2 passed to a detector. Since the amount of CO_2 produced is large compared to the internal volume of the system, the transient concentration of CO_2 greatly exceeds the ambient-air baseline for the brief duration of the pulse. This means that ambient air may be used as the carrier gas. The CO_2 concentration over baseline is accurately measured and integrated to give the Total Carbon content of the sample



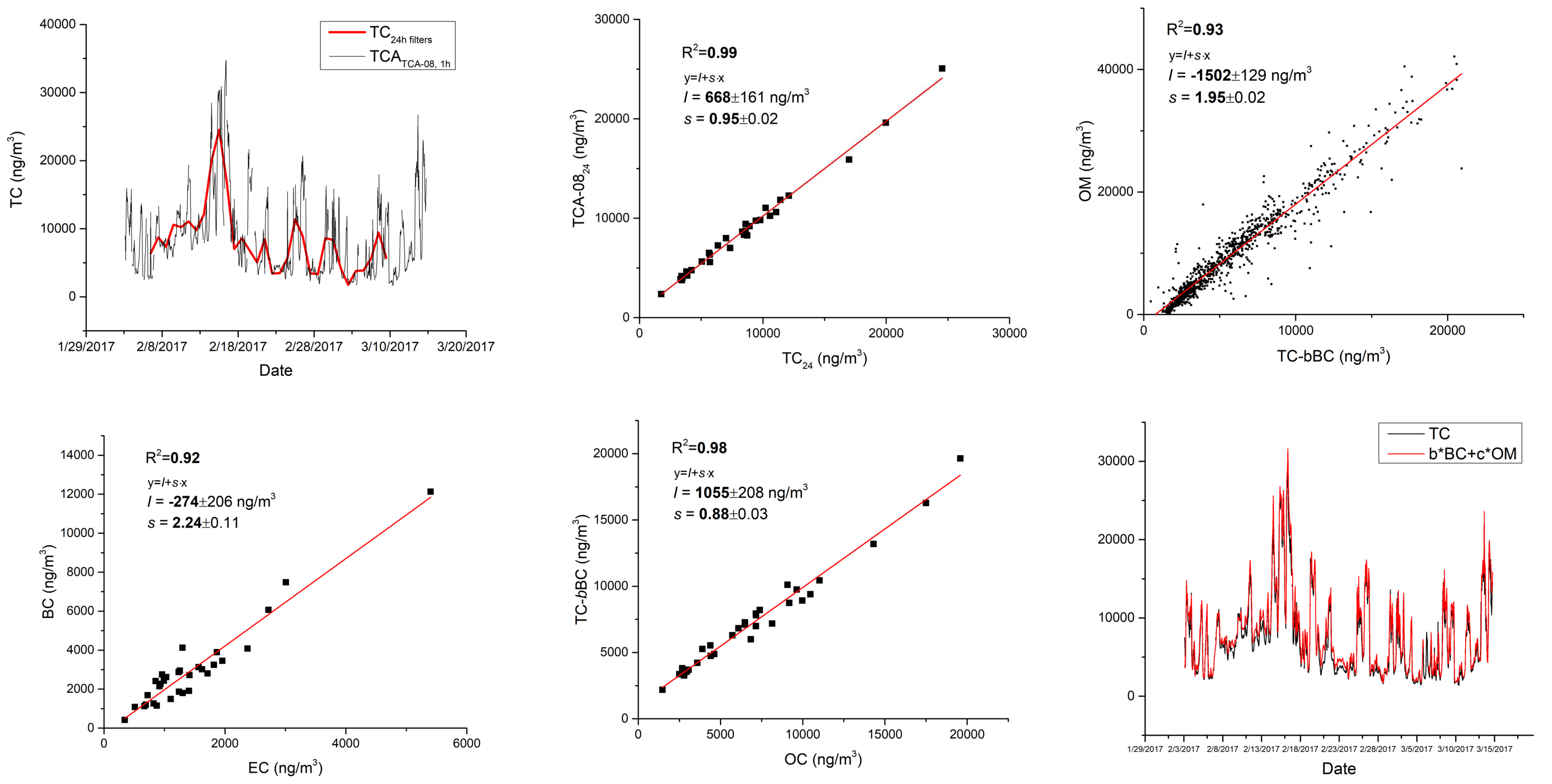


CAMPAIGN

- Ljubljana basin (SLO)
- Population 500 000
- Urban background location
- 07 Feb - 10 Mar 2017, 31 days



RESULTS

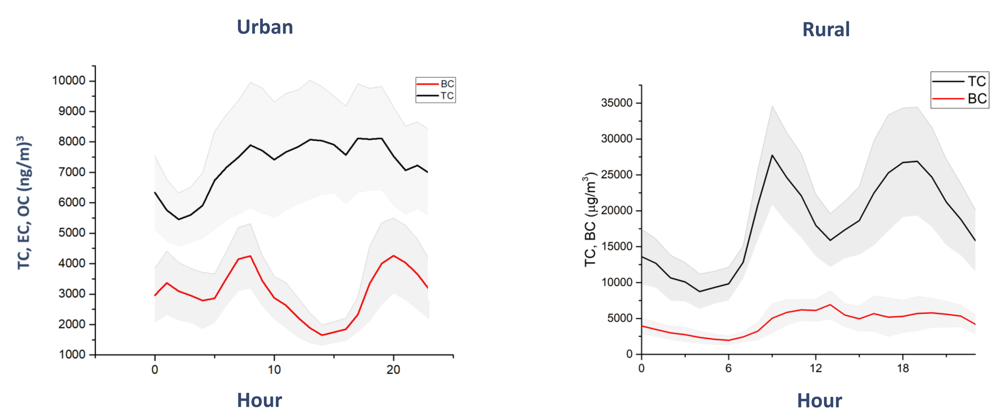


METHOD COMPARISON

x	Y	N	R^2	s	i
TC_{ARSO}	TC_{CNRS}	31	0.99	1.095 ± 0.015	-3.429 ± 0.646 $\left[\frac{\mu g}{cm^2}\right]$
OC_{ARSO}	OC_{CNRS}	31	1.00	1.091 ± 0.015	-3.535 ± 0.549 $\left[\frac{\mu g}{cm^2}\right]$
EC_{ARSO}	EC_{CNRS}	31	0.93	0.957 ± 0.047	1.018 ± 0.331 $\left[\frac{\mu g}{cm^2}\right]$
TC_{ARSO}	TC^{24h}_{TCA08}	31	0.99	0.955 ± 0.017	688 ± 161 $\left[\frac{ng}{m^3}\right]$
TC_{CNRS}	TC^{24h}_{TCA08}	31	0.99	0.869 ± 0.016	1357 ± 157 $\left[\frac{ng}{m^3}\right]$
EC_{ARSO}	BC^{24h}_{AE33}	31	0.80	2.068 ± 0.191	339 ± 302 $\left[\frac{ng}{m^3}\right]$
EC_{CNRS}	BC^{24h}_{AE33}	31	0.92	2.243 ± 0.120	-275 ± 206 $\left[\frac{ng}{m^3}\right]$
OC_{ARSO}	$TC^{24h}_{TCA08} - b_A BC^{24h}_{AE33}$	31	0.98	0.867 ± 0.024	1069 ± 199 $\left[\frac{ng}{m^3}\right]$
OC_{CNRS}	$TC^{24h}_{TCA08} - b_C BC^{24h}_{AE33}$	31	0.98	0.811 ± 0.020	1693 ± 165 $\left[\frac{ng}{m^3}\right]$
OM_{ACSM}	$TC^{1h}_{TCA08} - b_A BC^{1h}_{AE33}$	920	0.92	1.976 ± 0.019	-1513 ± 132 $\left[\frac{ng}{m^3}\right]$
OM_{ACSM}	$TC^{1h}_{TCA08} - b_C BC^{1h}_{AE33}$	920	0.93	1.935 ± 0.018	-1496 ± 128 $\left[\frac{ng}{m^3}\right]$

CONCLUSIONS and FUTURE WORK

1. **NEW METHOD**
   OC = TC - ***b***BC
2. **NEW INSTRUMENT**
   Total Carbon Analyzer **TCA-08**
3. **EQUIVALENCE**
   SOP: Ljubljana Winter 2017 Campaign
4. **HIGH RESOLUTION APPLICATIONS**
   ACSM/AMS calibration, diurnal profiles



GLOBAL CAMPAIGN:
Ljubljana (SLO), Zürich (CH), Magadino (CH), Beijing (CN), New Delhi (IN), Loški Potok (SLO), London (UK), Milano (IT), Paris (FR), LA (USA)…