

Offline Validation of the New 'Total Carbon Analyzer'

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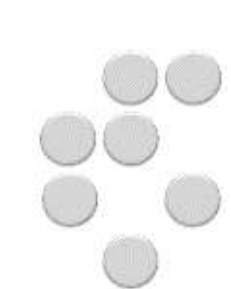
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Introduction

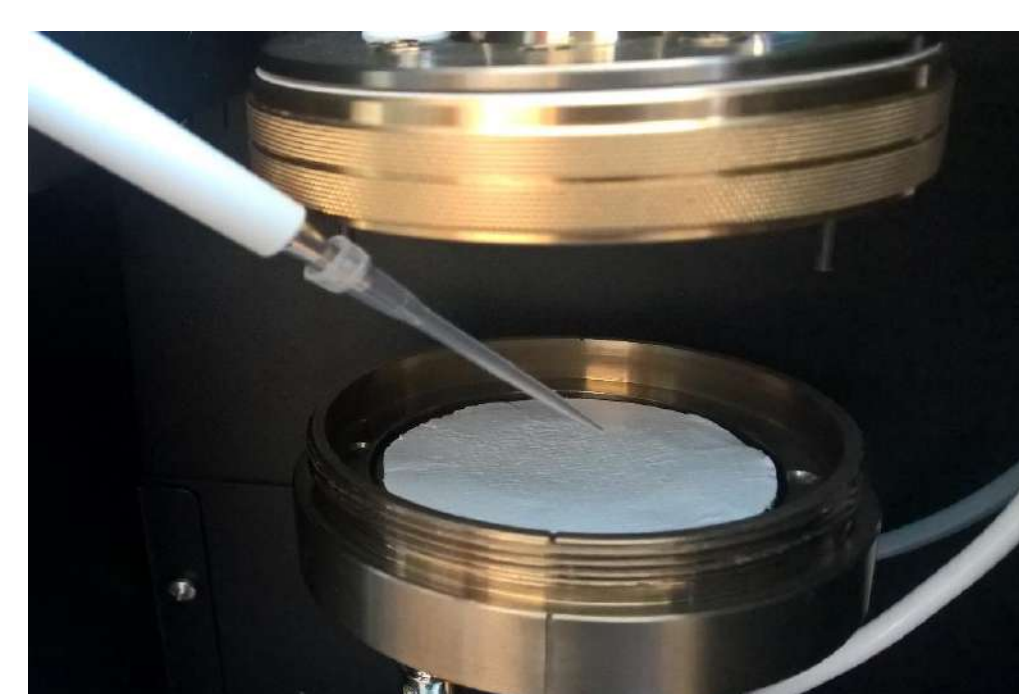
Carbonaceous aerosols are a large and often dominant fraction of fine particulate matter and are extremely diverse. The carbonaceous fractions are frequently separated into organic carbon (OC) and elemental carbon (EC) using thermal-optical methods. While the results for OC and especially EC concentrations vary significantly for different thermal evolution protocols (Bae, 2009), the total carbon (TC) concentration is very consistent between methods (Karanasiou, 2015). We present a new instrument TCA-08 for highly time resolved online measurement of TC concentrations. Combination of the optical method for measuring black carbon (BC) by the Aethalometer AE-33 (Hansen, 1982; Drinovec, 2015) and a thermal method for TC determination by newly developed TCA-08 is a new method (TC-BC) which we show to be equivalent to the standardized OC/EC analysis (EN 16909:2017).

Offline validation

The first step in the validation of the online TC-BC method is to confirm the simplified method of the new instrument and to compare the offline analysis of samples relative to the standardized OC/EC method. For this purpose we used:

(1) A series of different sucrose concentrations pipetted on quartz filter.

(2) Punches of 24-h samples of ambient PM, collected by a high-volume PM2.5 sampler (winter campaign in 2013), Magadino (Switzerland), analyzed by two independent laboratories (PSI, Villigen; CRNS, Grenoble) with Sunset offline OC/EC analyzer, using thermal protocol EUSAAR2.



(1) Pipetting different sucrose concentrations.



(2) Location of the measuring station Locarno-Magadino (CH).

Total Carbon Analyzer

The TCA-08 can operate in both online and offline modes. Quartz filter in the is combusted very rapidly using **filtered ambient air** as the carrier gas. This creates a CO₂ pulse which is readily detected as a large transient increase above the ambient CO₂ level. In contrast to conventional OC/EC analyzers, the new TCA method measures TC on the quartz filter without the need for special high purity gases, quartz glass components or specially-prepared catalysts (3).



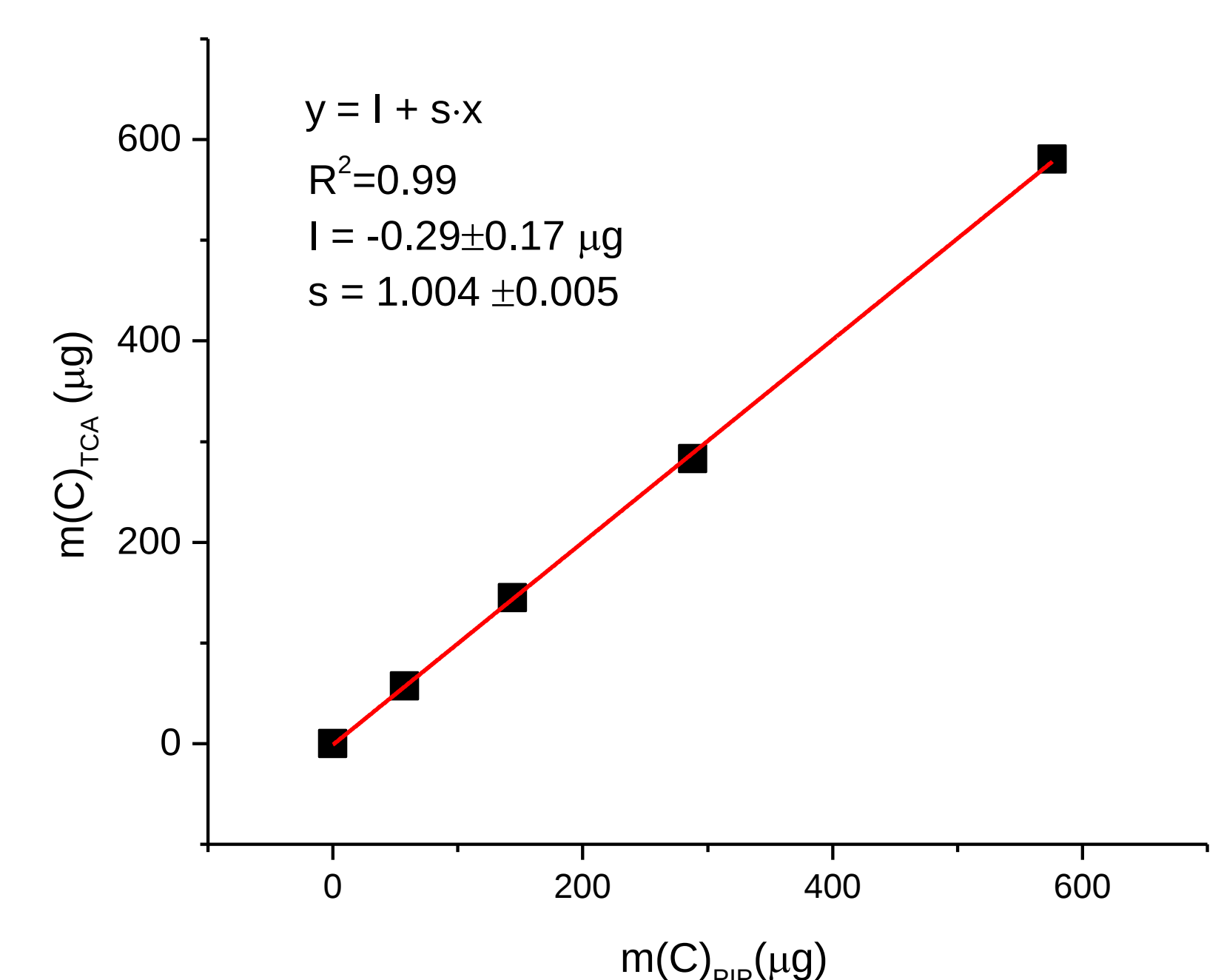
(3) Combustion chamber in TCA-08.

Results

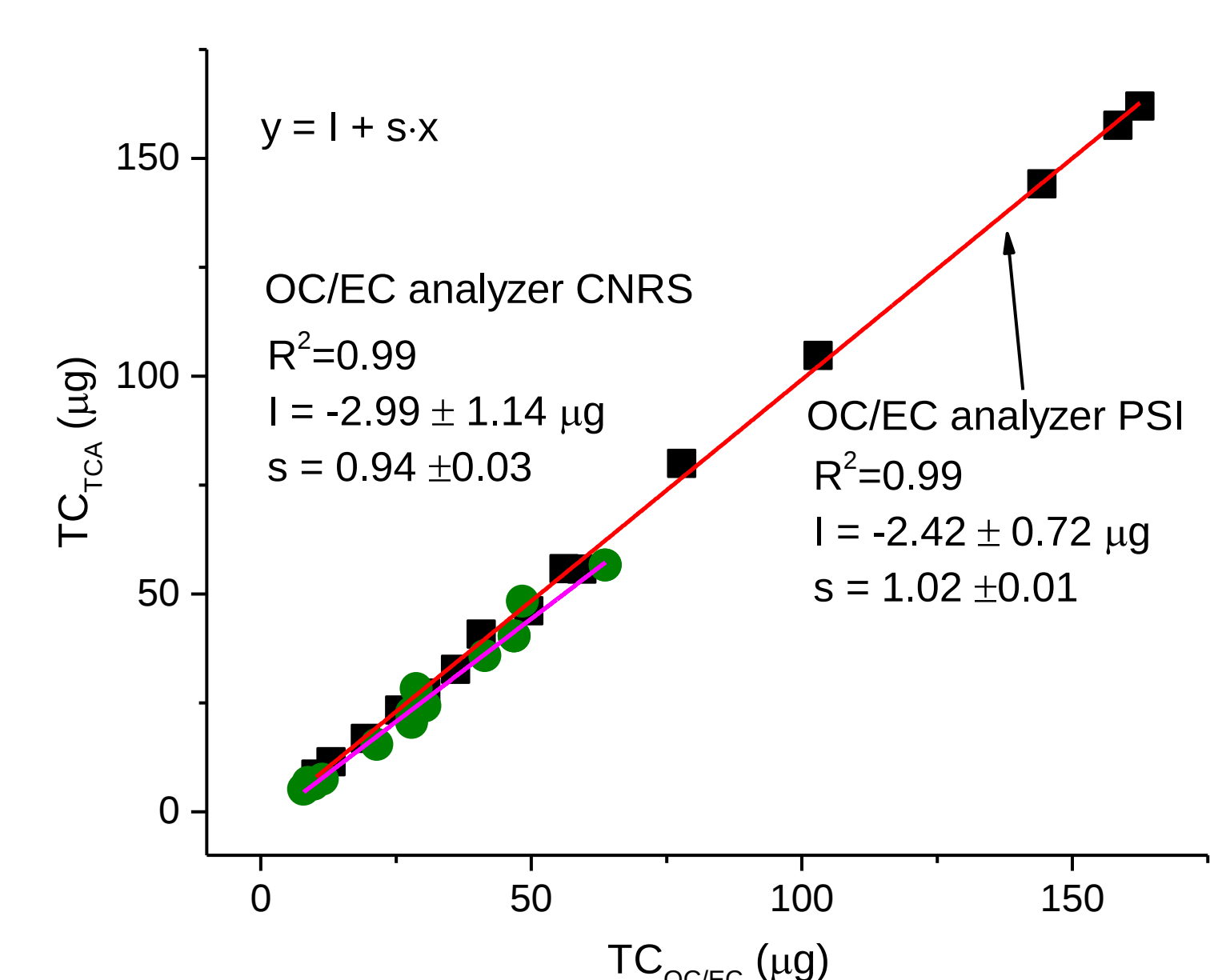
TC concentrations measured by Total Carbon Analyzer in offline mode were compared with known amount of carbon in different sucrose solutions (4) and with TC concentrations of ambient filters obtained by offline OC/EC instruments from two different laboratories (5).

Regression analysis of experiment with sucrose solutions showed excellent consistency between pipetted amount of carbon in sucrose and measured carbon from the CO₂ signal with TCA in the range of 5.0 µg to 0.5 mg of carbon. Additionally, adequacy of calibration of TCA with sucrose was confirmed. Comparison analysis on ambient samples with TCA and OC/EC analyzers also showed high correlation but small discrepancy between slopes for OC/EC analyzers CNRS and PSI, which can be explained in terms of the differences in calibrations and the sample composition.

This study confirmed performance of the simplified TCA method. It was a first step in demonstration of the equivalence between TC-BC method and standardized OC/EC method.



(4) Regression analysis of comparison between pipetted mass of carbon ($m(C)_{pip}$) from different volumes of sucrose solutions and measured mass of carbon ($m(C)_{TCA}$) determined from CO₂ signal by Total Carbon Analyzer.



(5) Regression analysis of comparison between TC concentrations of ambient filters obtained by offline OC/EC instruments ($TC_{OC/EC}$) from two different laboratories and TC concentrations measured by Total Carbon Analyzer in offline mode (TC_{ICA}).

References

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