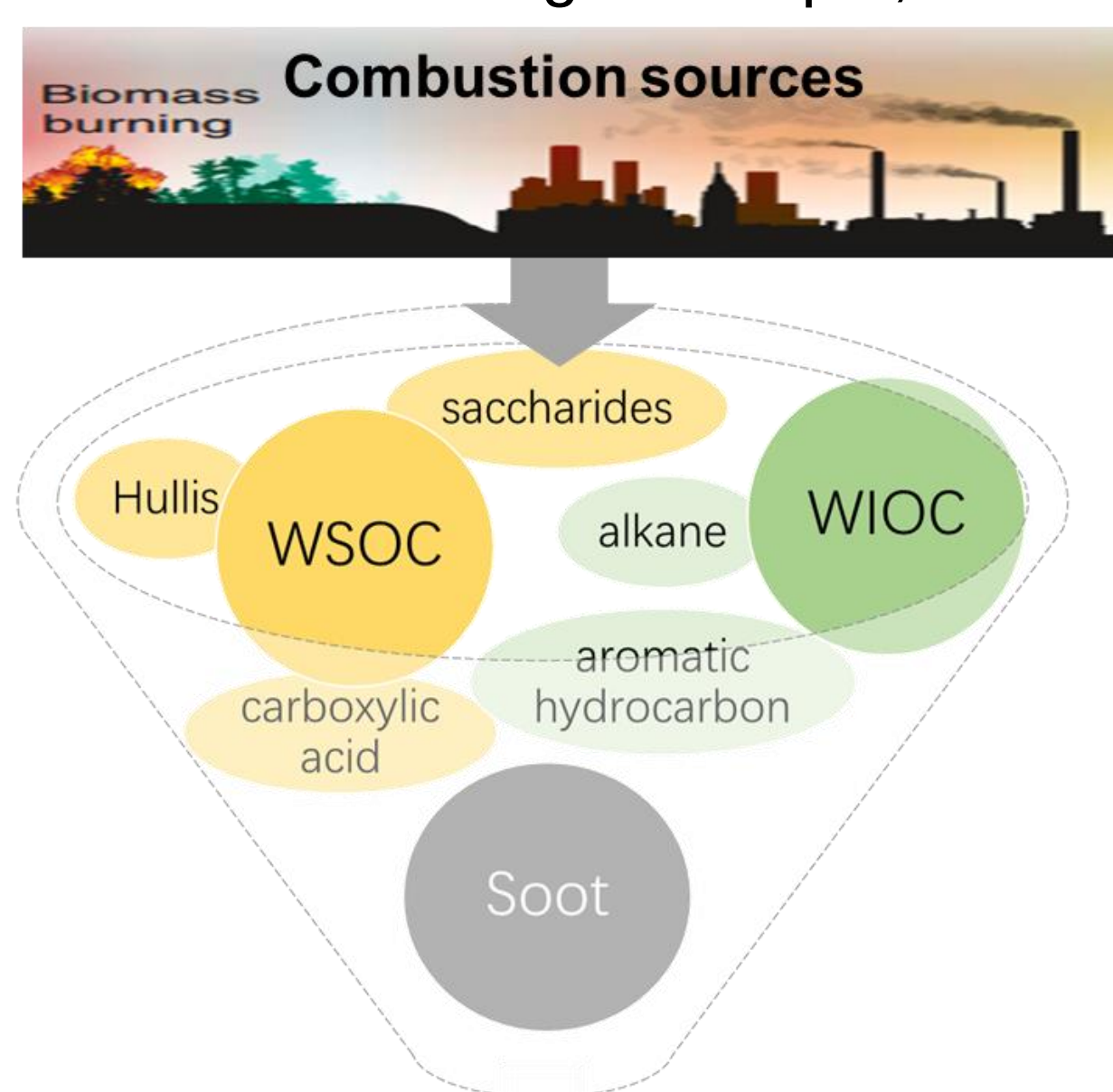


Introduction

Carbonaceous aerosol, including organic carbon (OC) and elemental carbon (EC), has significant influence on human health, air quality and climate change. Accurate measurement of carbonaceous aerosol is essential to reduce the uncertainty of radiative forcing estimation and source apportionment. The accurate separation of OC and EC is controversial due to the charring of OC. Therefore, the development of reference materials (RM) for the validation of OC/EC separation is an important basis for further study.

Previous RMs were mainly based on ambient air sampling, which could not provide traceability of OC and EC concentration. To develop traceable RMs with known OC/EC contents, our study applied an improved aerosol generation and mixing technique, providing uniform deposition of particles on quartz filters. To generate OC aerosol with similar pyrolytic property of ambient aerosol, both water soluble organic carbon (WSOC) and water insoluble organic carbon (WIOC) were used, and amorphous carbon was selected for EC surrogate.



1. Homogeneity of the filter-based RMs

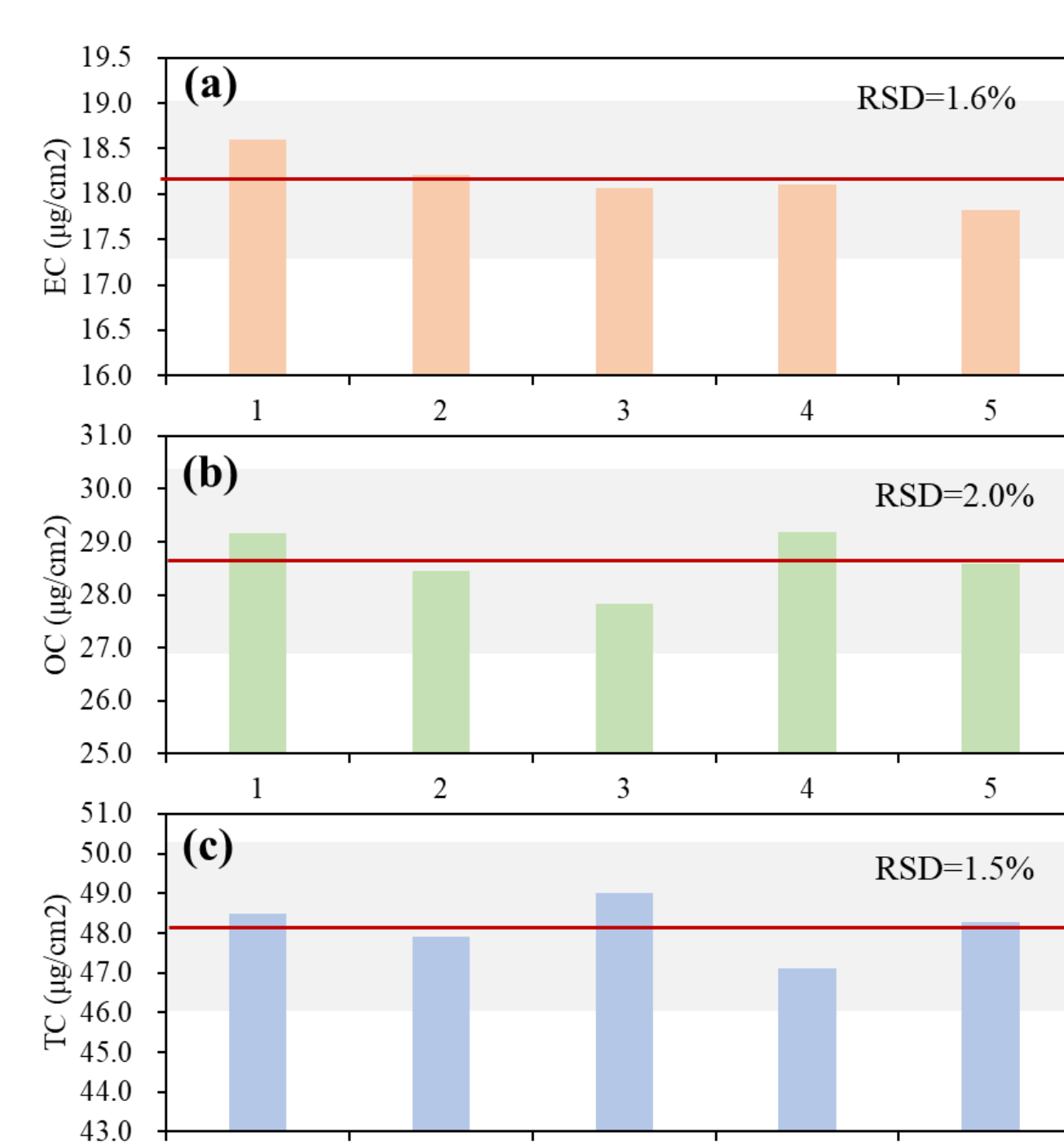


Fig. 2 Homogeneity of (a) EC-RM, (b) OC-RM and (c) OCEC-RM

➤ In general, relatively high homogeneity within filters were observed for three types of RMs with RSD below 3% and all measurements fell within $\pm 3\sigma$, indicating that the OC and EC aerosol were fully mixed and evenly deposited through the aerosol generation and collection system, which could be further applied for preparing laboratory filter-based RMs.

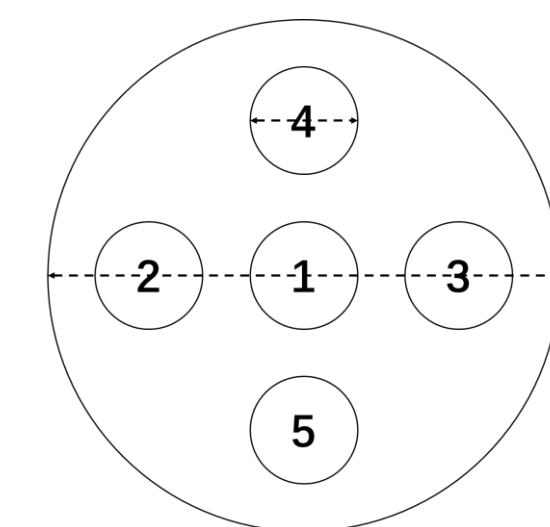


Fig. 1 Schematic of sampling for the homogeneity test

All OCEC-RMs exhibited relatively good homogeneity with RSD below 4% and z-score within the range of (-2, 2), and the homogeneity did not show obvious tendency with the concentration.

2. Stability of the filter-based RMs

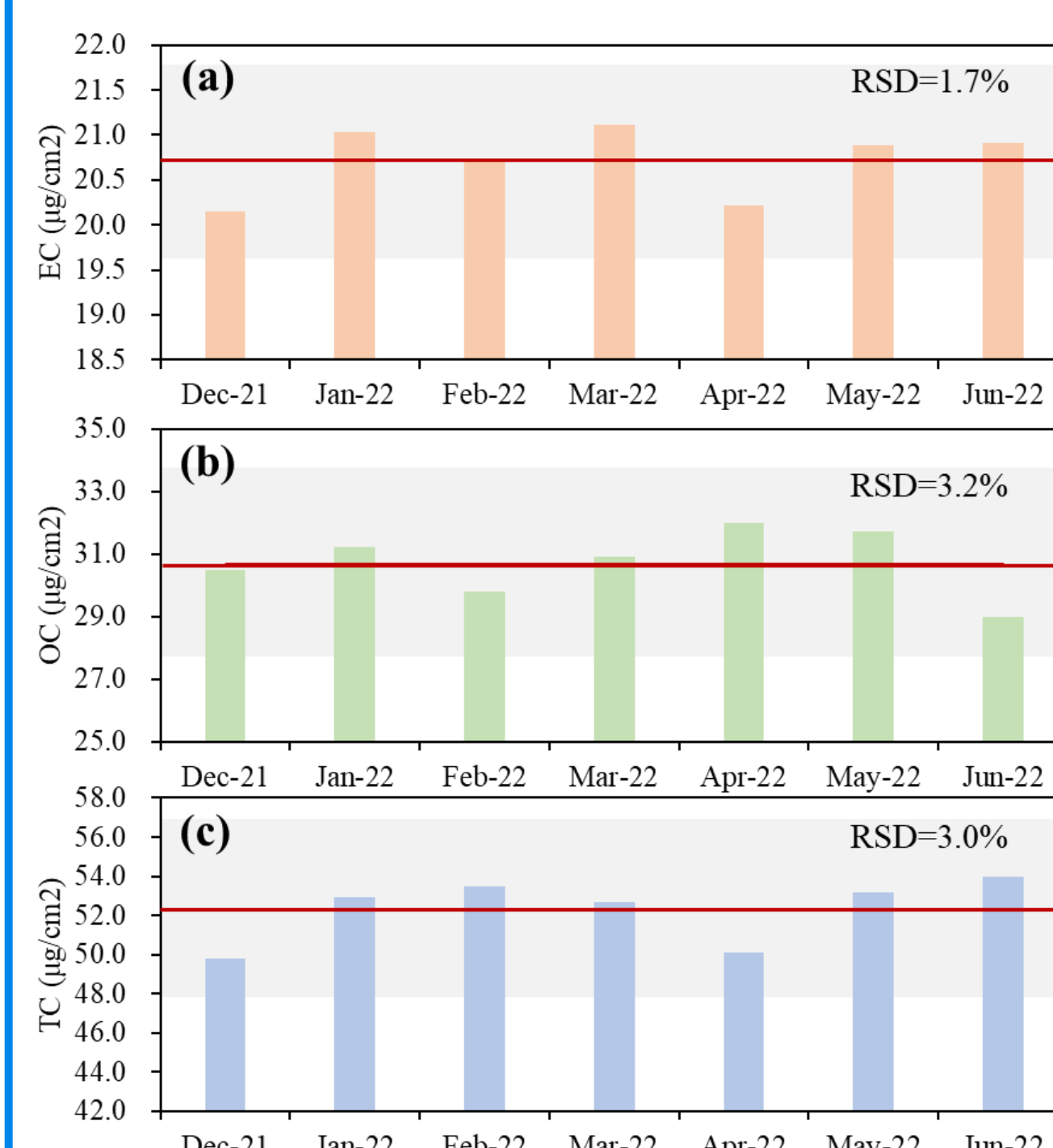


Fig. 4 Stability of (a) EC-RM, (b) OC-RM and (c) OCEC-RM

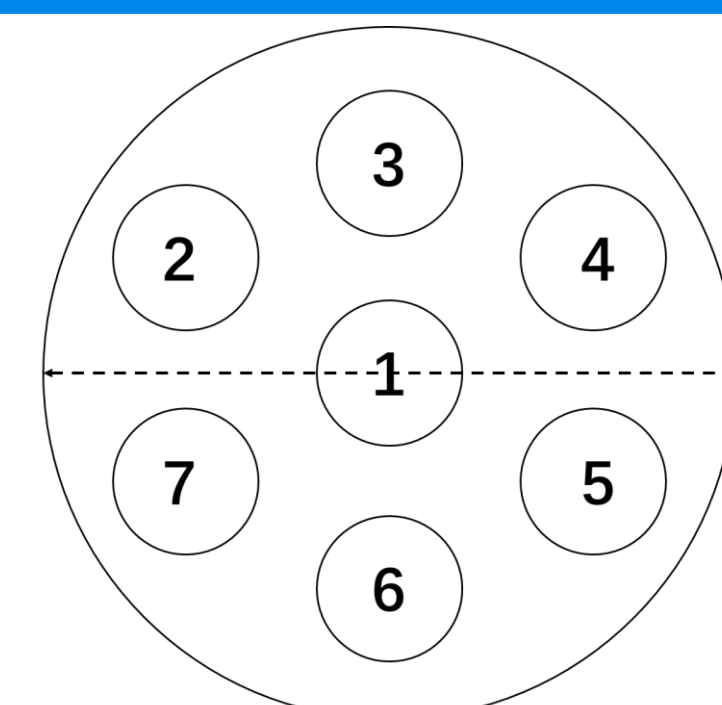


Fig. 3 Schematic of sampling for the stability test

- It could be seen that EC-RM showed best stability in 7 months with the RSD of 1.7%, which could be attributed to the stable chemical property of carbon black used as EC surrogate.
- The RSD of OC-RM and OCEC-RM were slightly higher than that of EC-RM, which were 3.2% and 3.0%, respectively.

➤ The variation of carbon concentration every month remained within $\pm 3\sigma$, and no obvious increasing or decreasing trend was observed for the three types of RMs. Therefore, the laboratory-generated filter-based RMs of carbonaceous aerosol exhibited good stability for a relatively long period.

3. Evaluation of the instrument performance with different protocols

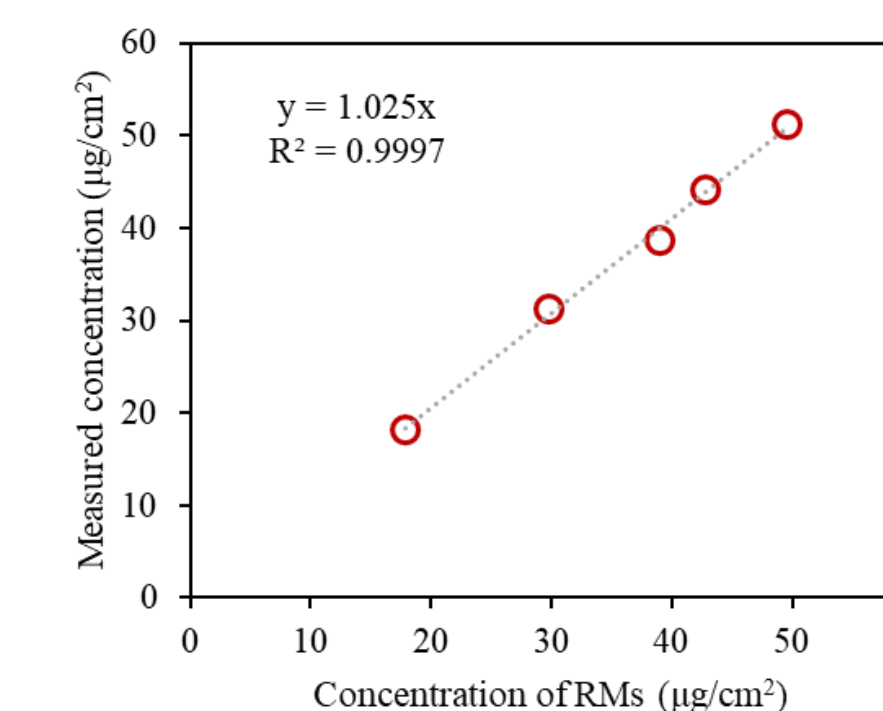


Fig. 5 Comparison of TC concentration of RMs with that measured by IMPROVE protocol

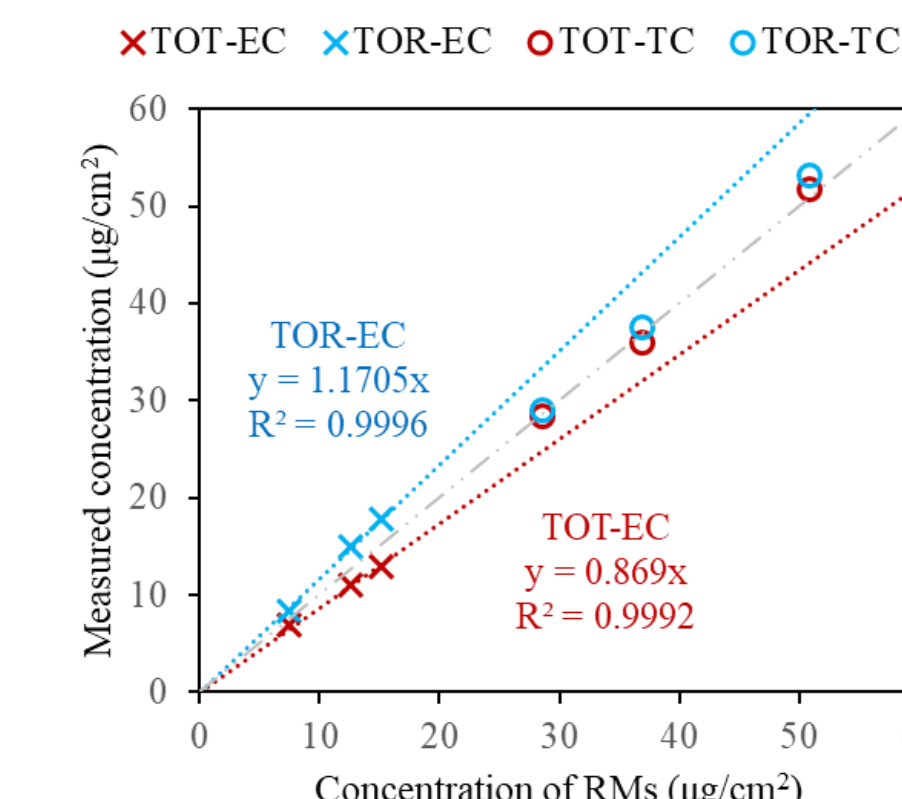


Fig. 6 Comparison of TC and EC concentration of RMs with that measured by IMPROVE_A-TOR protocol and NIOSH 870-TOT protocol.

The R^2 of the standard curve for the two protocols were relatively good, and the difference between the nominal values of the RMs and the measured concentration by two protocols was within 20%.

4. Further potential application for optical filter-based BC calibration

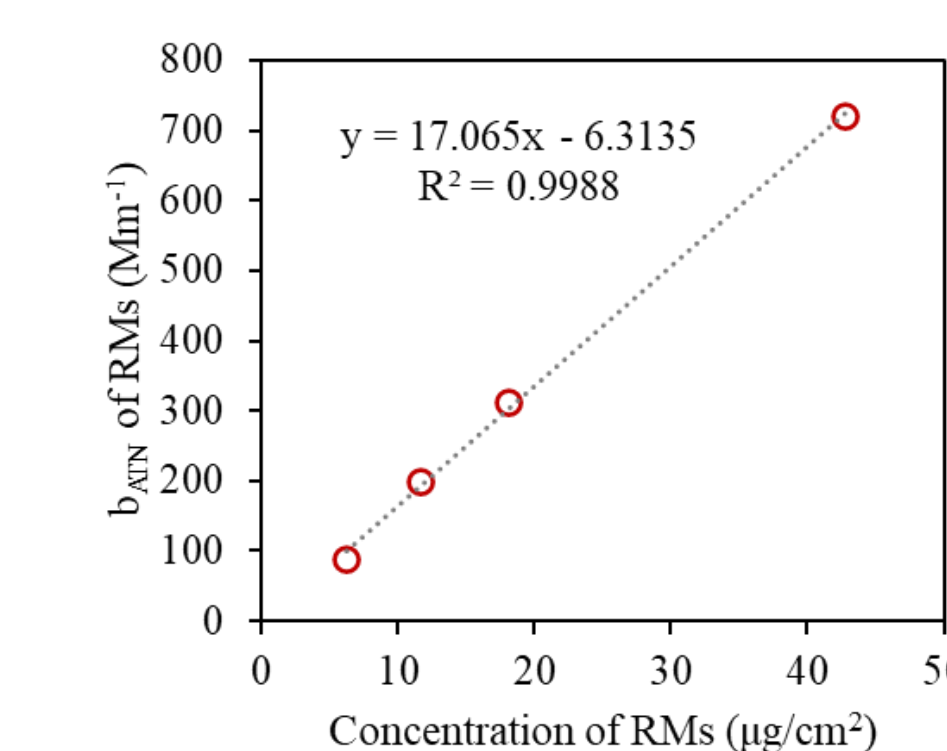
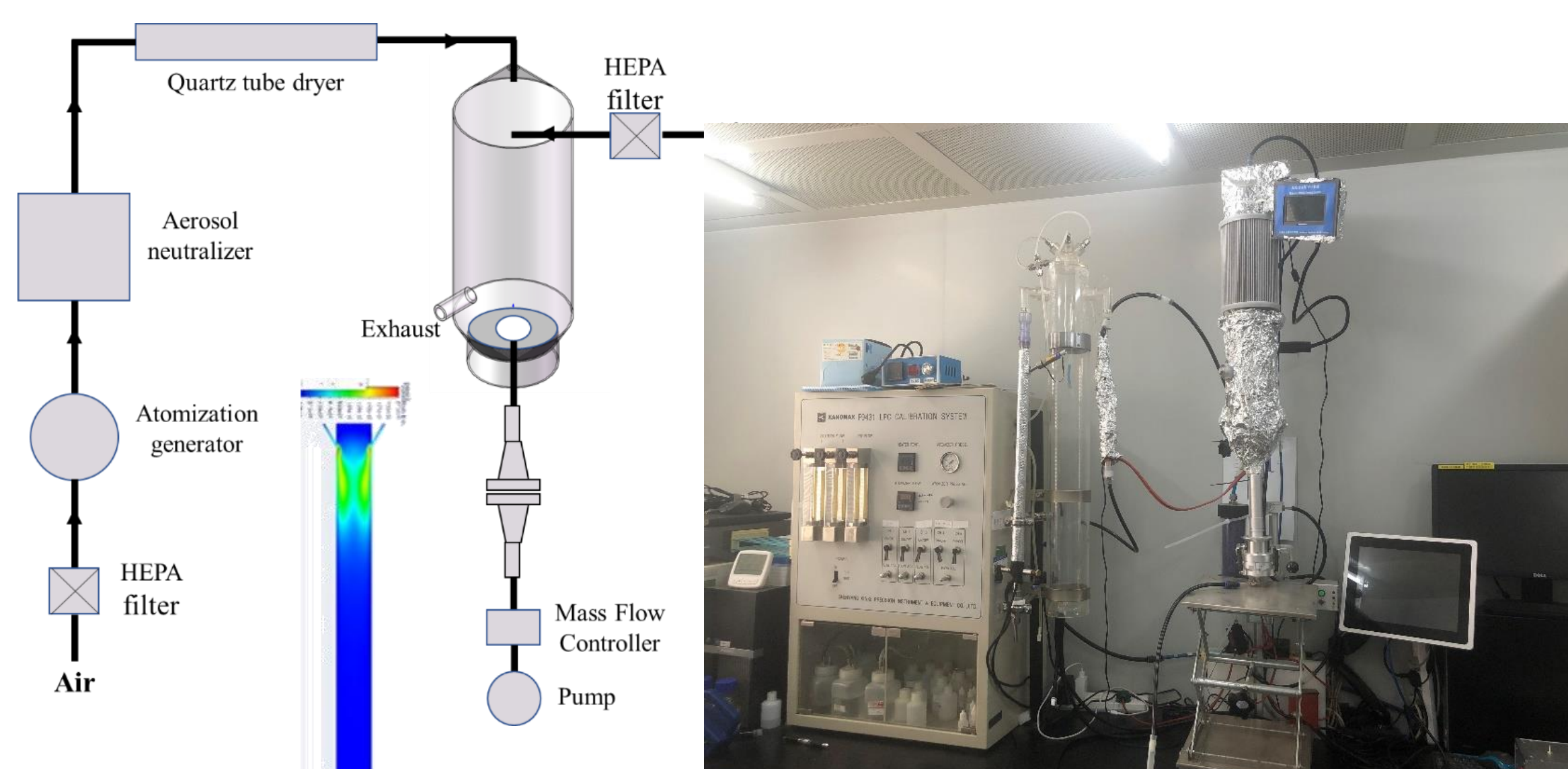


Fig. 7 Comparison of bATN measured by AE31 with the nominal concentration of EC-RMs

- High correlation was observed between AE31 and EC-RMs with R^2 over 0.99. The slope of the correlation curve was 17.1, which was higher than the mass specific attenuation cross section (MAC) for BC under 880 nm (16.6 m² g⁻¹) adopted by AE31

Experimental set-up and protocol

Schematic of carbonaceous aerosol generation and collection system



- To develop traceable RMs with known OC/EC contents, we applied an improved aerosol generation and mixing technique, which could provide uniform deposition of OC and EC on quartz filters. The traceability of the RMs was realized by the gravimetric method.

Conclusion

- To validate the accurate split of OC and EC through TOA method, traceable filter-based RMs of carbonaceous aerosol were successfully developed based on an improved aerosol generation and mixing technique, ensuring uniform deposition of OC and EC on quartz filters.
- The accurate measurement of OC and EC might further help reduce the estimation uncertainty of source contribution and radiative forcing of carbonaceous aerosol. Nevertheless, the application of the developed RMs need to be expanded in the future.

Acknowledgements

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