



Supplement of

Improving the predictions of black carbon (BC) optical properties at various aging stages using a machine-learning-based approach

Baseerat Romshoo et al.

Correspondence to: Baseerat Romshoo (baseerat@tropos.de) and Marius Kloft (marius.kloft@cs.rptu.de)

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Results in terms of percentage error

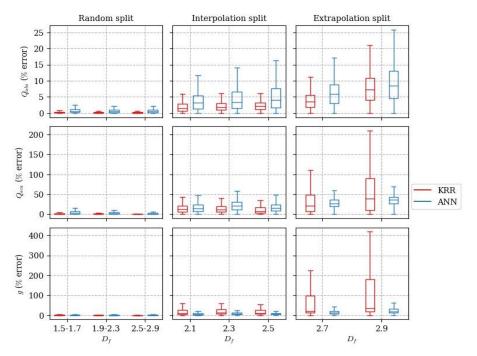


Figure S1. Boxplots summarizing the percentage error between the predicted value and the true value for three optical properties with respect to $D_{\rm f}$.

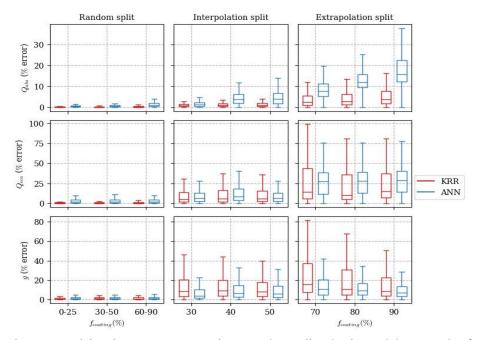


Figure S2. Boxplots summarizing the percentage error between the predicted value and the true value for three optical properties with respect to $f_{coating}$.

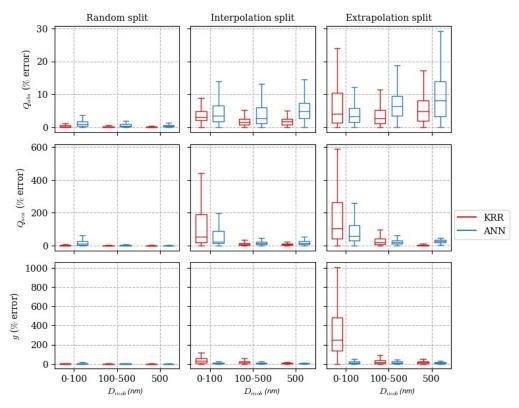


Figure S3. Boxplots summarizing the percentage error between the predicted value and the true value for three optical properties with respect to D_m .

Lifecycle of BC

Global Regime Regional Regime Brown carbon (BrC) bleaching Material loss due to volatility Local (Source) Regime Competing chemical and physical processes: Cloud processing Photochemistry, SOA production, Wet/dry deposition **Fuel source** Condensation, Oxidation, **Combustion conditions:** Fragmentation, Evaporation, Flaming (favors BC) Production of brown carbon, Smoldering (favors OA) Oligomerization Pyrolysis (favors OA) Cooling/dilution **Coagulation & condensation POA evaporation Minutes to Hours** Hours to Days to Weeks Days

Figure S4. Lifecycle of BC particles adapted from Sedlacek et al., 2022.

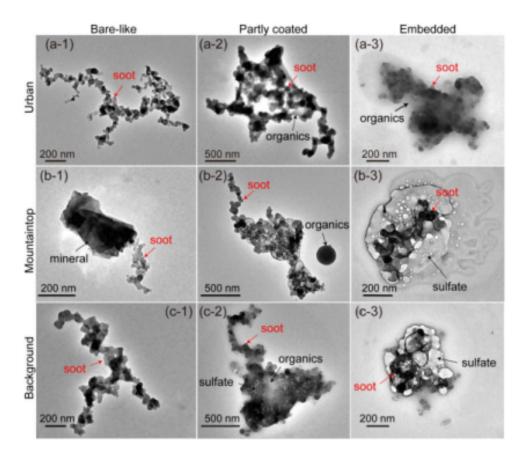


Figure S5. Transmission electron microscopy (TEM) images adapted from Fu et al., 2012 showing wide range of BC morphologies at different locations.

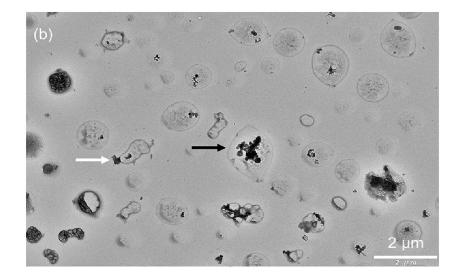


Figure S6. Results from TEM analysis showing that aged transported soot can retain its fractal morphology 500 to 1000 km downwind of emission source, taken from Sun et al., 2022.

References:

Fu, H., Zhang, M., Li, W., Chen, J., Wang, L., Quan, X., and Wang, W.: Morphology, composition and mixing state of individual carbonaceous aerosol in urban Shanghai, Atmos. Chem. Phys., 12, 693–707, https://doi.org/10.5194/acp-12-693-2012, 2012.

Sun, C., Adachi, K., Misawa, K., Cheung, H. C., Chou, C. C. K., & Takegawa, N. (2020). Mixing State of Black Carbon Particles in Asian Outflow Observed at a Remote Site in Taiwan in the Spring of 2017. Journal of Geophysical Research: Atmospheres, 125(16). <u>https://doi.org/10.1029/2020JD032526</u>

Sedlacek, A. J., Lewis, E. R., Onasch, T. B., Zuidema, P., Redemann, J., Jaffe, D., & Kleinman, L. I. (2022). Using the Black Carbon Particle Mixing State to Characterize the Lifecycle of Biomass Burning Aerosols. Cite This: Environ. Sci. Technol, 2022, 14315–14325. https://doi.org/10.1021/acs.est.2c03851