Responses to anonymous referee #1

General comment:

This work uses field measurements of aerosol size, composition, and optical properties to constrain estimates of the real part of the refractive index for organic aerosol. Based on statistical characterization of the organic spectra using PMF, the authors were able to identify organic aerosol types as having primary and secondary sources. Combined with this identification and direct DMA-SP2 measurements, the authors quantified contributions of the different aerosol types to the refractive index and recommended revised estimates of refractive index for POA and SOA. The analysis in this paper is cleverly carried out and thorough, providing fidelity to the arguments and new refractive index recommendations. The figures clearly illustrate discussions in the text. The paper is generally well written but there are a lot of grammatical errors and the sentence structure is at times difficult to follow. In some places I noted where these were and made suggestions, but the issues were far too numerous to point out each one. The authors should make a concerted effort to carefully re-read the paper to ensure its clarity. I believe this paper is appropriate for this journal but should only be accepted after the authors address the following minor comments.

Response: Thanks for your comments, which really helped improve the manuscript and we have scrutinized the manuscript to ensure its clarity.

Minor Comments:

Comment: Line 109-110: The authors should cite the manufacturer of the SP2 (Droplet

Measurement Technologies).

Response: The manufacturer cited as "with single-particle soot photometer from Droplet Measurement Technologies, Boulder, Colorado (Schwarz et al., 2006)."

Comment: Lines 105-115: The authors have not provided any discussion on the set up or quantified the inlet and loss properties of the instrument set up and sampling system. This information must be included. What altitude were the aerosol sampled from? Were the measurements continuous? Were the aerosol collected in a container using one main inlet? Was there an impactor or cyclone before sampling into the instruments? What was the main inlet flow and instrument flows? Have the authors quantified the sampling losses to the instruments? How were the aerosol dried? How was the relative humidity monitored?

Response: Thanks for pointing this out. This information was added as "Aerosol absorptions at multiple wavelengths were measured using the AE33 from MAGEE (Drinovec et al., 2015). Note that a PM2.5 inlet (BGI, SCC 2.354) with a required flow rate of 8 L/min was used for aerosol sampling, with a Nafion drier of 1.2 m length downstream of the impactor, which ensures the sampling RH in instruments could be down to around 10% as recorded by the inlet RH sensor of the Q-ACSM. The flow rates of the Q-ACSM, SMPS, SP2 and AE33 instruments were set to 3 L/min, 0.3 L/min, 0.1 L/min, and 5 L/min, respectively. Nafion drier and all sampling tudes before instruments were placed vertically to reduce sampling loss."

Comment: Line 116: can the authors provide a citation for how this equation was

derived?

Response: The reference was added: (Zhao et al., 2019)

Comment: Line 140: what type of nephelometer was used? Please provide the same information where relevant as in my second comment.

Response: Added, "using a nephelometer (Aurora 3000 from Ecotech, (Müller et al., 2011))"

Comment: Line 166: no need to redefine PMF.

Response: Revised.

Comment: Figure S4 caption: revise text to, "[Comparison of] dry-state aerosol …".

Response: Revised.

Comment: Figure S5 and S7: how is the relative deviation calculated? Please specify.

Response: Clarified, "The ranges of relative deviations were calculated as the relative differences in scattering coefficients between simulations using the lowest and highest values of the variable and those using the default value represented as black circle."

Comment: Line 302-304: The authors state that the chemical composition at mr1064,400 of 1.56 has higher MOOA content. Higher than what? The mr1064,400 at 1.48? Please specify which mr1064,400 and MOOA content are being referenced in the text.

Response: Revised as "corresponding to $m_{r1064,400}$ of 1.56 has an overall higher content of MOOA than that near $m_{r1064,400}$ of 1.48."

Comment: Figure 4: please specify that the red line in these panels is the 1:1 line in the caption.

Response: Added, "Red lines indicate the 1:1 reference lines."

Comment: F Line 454: Grammar: "…increase mrc525 from 1.37 to 1.59 would [result?] in a ~60%..."

Response: Yes, result in, revised.

Comment: Line 474-477: This sentence is too long and confusion. It should be split into two sentences for clarity.

Response: Split into two sentences: "This is likely associated with that MOOA in Guangzhou urban area is mainly formed through multiphase reactions (Zhai et al., 2023) thus has higher m_r as demonstrated by Li et al. (2017) that multiphase reactions enhance m_r. Most laboratory studies on evolution of $m_{r,SOA}$ were conducted in the context of gas-phase reactions."

Comment: Data availability: In accordance with ACP guidelines (https://www.atmospheric chemistry-and-physics.net/policies/data_policy.html) that "authors are required to provide a statement on how their underlying research data can

be accessed", the authors must provide a resource that contains their deposited data to "guarantee the integrity, transparency, reuse, and reproducibility of scientific findings." If this is not possible, the authors need to clarify why their data is not being shared. This should be in the Data Availability section at the end of the manuscript.

Response: The following statement was added "Data Availability. All data presented in Figures of this manuscript are freely available at https://doi.org/10.5281/zenodo.15786937, and more specific raw data will be made available on request due to the data restriction policy."

References:

Drinovec, L., Močnik, G., Zotter, P., Prévôt, A. S. H., Ruckstuhl, C., Coz, E., Rupakheti, M., Sciare, J., Müller, T., Wiedensohler, A., and Hansen, A. D. A.: The "dual-spot" Aethalometer: an improved measurement of aerosol black carbon with real-time loading compensation, Atmospheric Measurement Techniques, 8, 1965-1979, 10.5194/amt-8-1965-2015, 2015.

Li, K., Li, J., Liggio, J., Wang, W., Ge, M., Liu, Q., Guo, Y., Tong, S., Li, J., Peng, C., Jing, B., Wang, D., and Fu, P.: Enhanced Light Scattering of Secondary Organic Aerosols by Multiphase Reactions, Environmental science & technology, 51, 1285-1292, 10.1021/acs.est.6b03229, 2017.

Müller, T., Laborde, M., Kassell, G., and Wiedensohler, A.: Design and performance of a three-wavelength LED-based total scatter and backscatter integrating nephelometer, Atmos. Meas. Tech., 4, 1291-1303, 10.5194/amt-4-1291-2011, 2011.

Schwarz, J. P., Gao, R. S., Fahey, D. W., Thomson, D. S., Watts, L. A., Wilson, J. C., Reeves, J. M., Darbeheshti, M., Baumgardner, D. G., Kok, G. L., Chung, S. H., Schulz, M., Hendricks, J., Lauer, A., Kärcher, B., Slowik, J. G., Rosenlof, K. H., Thompson, T. L., Langford, A. O., Loewenstein, M., and Aikin, K. C.: Single-particle measurements of midlatitude black carbon and light-scattering aerosols from the boundary layer to the lower stratosphere, Journal of Geophysical Research: Atmospheres, 111, D16207, 10.1029/2006JD007076, 2006.

Zhai, M., Kuang, Y., Liu, L., He, Y., Luo, B., Xu, W., Tao, J., Zou, Y., Li, F., Yin, C., Li, C., Xu, H., and Deng, X.: Insights into characteristics and formation mechanisms of secondary organic aerosols in the Guangzhou urban area, Atmos. Chem. Phys., 23, 5119-5133, 10.5194/acp-23-5119-2023, 2023.

Zhao, G., Zhao, W., and Zhao, C.: Method to measure the size-resolved real part of aerosol refractive index using differential mobility analyzer in tandem with single-particle soot photometer, Atmos. Meas. Tech., 12, 3541-3550, 10.5194/amt-12-3541-2019, 2019.