**Referee #1**

The manuscript "A new multispectral photometer for monitoring aerosol microphysical, optical, and radiative properties" mainly describes a new multispectral photometer (CW193) proposed in this study. In this study, the design of multispectral photometer combines the merit of low maintenance requirements and being appropriate for the deployment in remote and unpopulated regions. In general, the paper is well written and presented in a logical way. It is a timely and important piece of work, and of general interest for Atmospheric Measurement Techniques related communities. I therefore recommend publication of this paper in Atmospheric Measurement Techniques after minor revisions. My comments are listed as follows:

**Response:** Thank you for giving us the opportunity to improve the quality of this manuscript. We have substantially revised this manuscript by following your insightful comments and constructive suggestions. Please find out our point-by-point responses below. We have studied comments carefully and have made correction which we hope meet with approval. Revised portion are marked in **red** in the revised paper.

Specific Comments:

1. Line 109-110, In the sentence of "the main pollution sources are derived from urban activities", the meaning of "source" has been already included in the word "derive".

**Response:** Thanks for pointing out. We have deleted this "source" in our manuscript.

*Lines 109-110 in the revised paper:*

*"…where the main pollution are derived from urban activities."*

2. Line 111, a description for is needed.

**Response:** Thanks for your suggestion. According to the comments, we guess a description for "CAMS" is needed in there. We added the full name of CAMS in our revised paper.

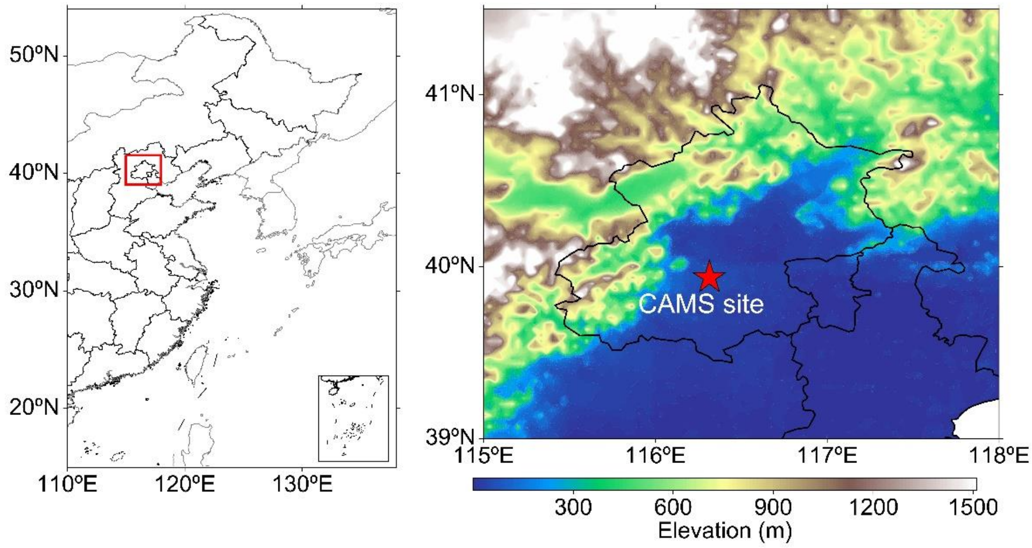
*Line 101 in the revised paper:*

*"…according to long-term ground-based aerosol measurements at CAMS (Chinese Academy of Meteorological Sciences) …"*

3. In figure 1, I suggest the authors add the map of China as well as the CAMS location. Otherwise, the readers cannot catch the location information of CAMS.

**Response:** Thanks for your constructive comment. We have re-plotted this figure as to show the location of CAMS more clearly.

*Line 120 in the revised paper:*




4. Line 141, the role of word "respectively" is indistinct in the sentence.

**Response:** Thanks for your kind suggestion. In this sentence, we try to explain that the AOD is calculated from the Sun radiation measurements and the other microphysical, optical, and radiative properties of aerosols is retrieved from sky radiation measurements. We have rewritten this sentence as follow to make this explanation more accurate.

*Lines 141-142 in revised paper:*

*"The CW193 is an automatic photometer and designed to obtain AOD and other retrievals (such as microphysical, optical, and radiative properties of aerosols) from Sun radiation and sky radiation monitoring."*

5. Line 204, Is the meaning of same as?

**Response:** Thanks for your suggestion. We check through this part in our paper, and guess that the additional explanation is needed for the method of Sun calibration of CW193. As usual, there are two main calibration method for the sun radiance—Langley plot method and coefficient transfer method. For the AEROENT, the master instruments are calibrated at Mauna Loa Observatory (3397 m a.s.l) and Izaña Observatory (2373 m a.s.l) via Langley plot method, and then the calibration coefficient is transferred to field instruments by inter-comparison. As for the CARSNET, its master instruments are calibrated by the Group of Atmospheric Optics (GOA, in Valladolid, Spain) at Izaña for every six months. In this campaign, the CW193 (could be regarded as field instrument) was calibrated via coefficient transfer method (inter-comparison) with the reference of AERONET master instruments according to the Eq. 1 as below,

$$C(\lambda) = C(\lambda)_0 \times \left(\frac{V(\lambda)}{V(\lambda)_0}\right) \ldots\ldots Eq.1$$

where the $C(\lambda)$ and $C(\lambda)_0$ is the calibration coefficient for field instrument and master instrument at $\lambda$ wavelength, respectively. $V(\lambda)$ and $V(\lambda)_0$ is the digital count for field instrument and master instrument at $\lambda$ wavelength, respectively. We have rewritten this sentence in paper and added one corresponding reference of coefficient transfer method to make it more accurate.

*Lines 204-205 in revised paper:*
*"...using the method of coefficient transfer (inter-comparison) with the reference master instruments of AERONET (Che et al., 2009, 2019c; Zheng et al., 2021)."*

*Che, H., Zhang, X., Chen, H., Damiri, B., Goloub, P., Li, Z., Zhang, X., Wei, Y., Zhou, H., Dong, F., Li, D. and Zhou, T.: Instrument calibration and aerosol optical depth validation of the China Aerosol Remote Sensing Network, J. Geophys. Res. Atmos., 114(D3), doi:10.1029/2008JD011030, 2009.*

6. Line 301 and Table 4, What is the standard of Level I-III? The corresponding information is needed.

**Response:** Thanks for your suggestions. In fact, we have already introduced the standard of Level I-III, and its classification is based on the ambient PM2.5 concentrations according to the ambient air quality standards of China (GB3095-2012, http://www.mee.gov.cn/gkml/hbb/bwj/201203/t20120302_224147.htm) in Lines 291-297. Briefly, Level I means the daily average $PM_{2.5}$ < 35 μg $m^{-3}$, and the Level II reflects the $PM_{2.5}$ concentration between 35 μg $m^{-3}$ and 75 μg $m^{-3}$, while the Level III indicates the daily average $PM_{2.5}$ between 75 μg $m^{-3}$ and 115 μg $m^{-3}$.

7. In the bottom description of Figure 7, the sentence "One–one line, linear regression line, and the EE envelopes of ±(0.05 + 10%) are plotted as red dashed, green solid, and black dashed lines" should be changed to "One–one line, linear regression line, and the EE envelopes of ±(0.05 + 10%) are plotted as red dashed, green solid, and black dashed lines, respectively".

**Response:** Thanks for your constructive suggestions. It has been corrected.

*Lines 204-205 in revised paper:*
*"Figure 7. Validation of CW193 AOD at each wavelength against AERONET AOD. One–one line, linear regression line, and the EE envelopes of ± (0.05 + 10%) are plotted as red dashed, green solid, and black dashed lines, respectively."*

8. In the calculations of ADRF for CW193 and instruments of CARSNET, and AERONET, does the authors use the same radiation transfer model? If the model is different, the difference of ADRF may not induced by the instrument alone.

**Response:** Thank you so much for your constructive comments. In this study, the ADRF was calculated by the radiative transfer module, which is similar to the inversion of AERONET (García et al., 2008, 2012). In our revised paper, we have re-organized the section 2.2.3 to present the data processing method in this campaign, including AOD, WV, VSD, SSA, ADRF and their uncertainties. In fact, these retrievals uncertainties (VSD, SSA and ADRF) are greatly affected by the calibration processing, because there is no absolute self-calibration procedure between the sphere calibration, indicating the differences of retrievals were joint determined by many factors, such as uncertainties of inherent algorithm assumption, input direct and sky radiance, surface albedo. As the results, in order to reduce the uncertainty from input radiance, we only used the results, which the observation interval is within 10 minutes to conduct the comparison. Through there are still some differences, we suggested that these results were comparable with the AERONET. In next step, we will further test its stability and accuracy based on long-term observation campaign, with the reference of AERONET results.

*Lines 214-229 in revised paper:*

*"We calculated the cloud-screened AOD and columnar water vapor of CW193 via the similar algorithm as AERONET. As the algorithm has been used multiple times in many observation campaigns, numerical modeling, and satellite verification for CARSNET, it is suitable and reliable to evaluate the AOD performance of CW193 using this method (Wang et al., 2010; Xia et al., 2021; Yu et al., 2015; Zhao et al., 2021c; Zheng et al., 2021). The algorithm verification is provided in the Supplementary Information to guarantee the accuracy in this campaign (Figures S1 and S2). As for the inversions of VSD and SSA in this campaign, they were retrieved from the observational data from the diffuse-sky measurements of the CW193 at 440, 670, 870, and 1020 nm using the algorithms of Dubovik et al. (2002, 2006). The ADRF was calculated by the radiative transfer module, which is similar to the inversion of AERONET (García et al., 2008, 2012). Because the introduction, validation and application of these inversions and their algorithms have been presented in many previous studies based on CARSNENT observation, we did not repeat these again in this paper (Che et al., 2018, 2019c; Zhao et al., 2018; Zheng et al., 2021). In general, the AODs' uncertainty was 0.01 to 0.02 (Eck et al., 1999). The VSD accuracy was 15 % to 25 % between 0.1 μm $\leq r \leq$7.0 μm while 25 % to 100 % for other radius (Dubovik et al., 2002). The SSA accuracy was 0.03 when its was calculated under the condition of AOD440 nm >0.50 with a solar zenith angle >50 ° (Dubovik et al., 2002). The bias for measured radiation at the surface was about 9±12 W $m^{-2}$, affected by the dominant aerosol type (García et al., 2008)."*