Referee #2

This paper presents a newly-designed sun photometer for aerosol retrieval. Compared to the widely used CE318 model, the new instrument has the advantage of better portability with similar accuracy. Inter-comparisons are carried out to evaluate the performance, which shows that the CW193 sunphotometer has comparable retrieval accuracy. The new instrument has the potential to be deployed in remote and desert regions, thus expanding the aerosol observation network. Overall, this is a well written paper with good scientific merit. I only have a few minor questions.

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.

Minor comments:

1. The design of CW193 is very similar to that of CE318. The authors indicated that the biggest advantage is CW193's portability. I suggest providing more detailed description about this. In Figure 2, only the optical head part is shown, or is this the whole system? If latter, I suggest making it clear as this indeed appears much more compact than CE318.

Response: Thanks for your constructive comment. Yes, the whole device is shown at the left part in Figure 2, which is consist of optical head, robotic drive platform and stents system. These three parts can be easily connected together only by a few screws. As for the its portability, it is really a main character for CW193. Except for its highly integrated design, the cross weight is about 12 kg, and this make it easier to transport. We have rewritten corresponding sentences in our paper.

Lines 143-147 in the revised paper:

"The instrument is mainly composed of three parts: optical head, robotic drive platform, and stents system (as shown in the left part of Figure 2). These three parts can be easily connected together only by a few screws. Except for its highly integrated design, the cross weight of CW193 is about 12 kg, and this make it easier to transport. Specifically, we presented the comparison of technical specifications between CE318-N and CW193 in table 1."

2. Does the retrieval of aerosol optical properties use the same inversion method as AERONET? Please briefly describe the retrieval method.

Response: Thanks for your kind suggestion. We used similar inversion method as AEROENT, which is developed by Dubovik et al. (2002, 2006) and (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.

Lines 220-229 in revised paper:

" 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 ≤r ≤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)."

3. In addition to comparing with AERONET and CARSNET, I think it is also very important to independent evaluate the measurement and retrieval accuracies of CW193. How accuracy are the sky and diffuse radiances? How are the errors in these measurements transferred to the retrieved products? Are these accuracy levels comparable, or better than AERONET?

Response: Thanks for your constructive suggestion. Yes, the independent validation of measurement and retrieval accuracies is an important processing for the instrument evaluation. As for the measurement, the wildly used mothed is the inter-comparison based on ground-based observation of broadband fluxes. In next step, we plan to conduct this inter-comparison at the radiation calibration center of Chinese Academy of Sciences in Dunhuang (40.15°N, 94.69°E, 1140 m a.s.l in Northwest China). So we just showed the corresponding results of aerosol microphysical, optical, and radiative properties in the present study. As for the uncertainties in retrieval method, we have added the data processing method, including AOD, WV, VSD, SSA, ADRF and their uncertainties in the re-organized section 2.2.3, as have mentioned above. As the result, considering the performance of these products, we concluded that the CW193's inversions are comparable with the AERONET.

Lines 220-229 in revised paper:

"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 ≤r ≤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)."

4. Could the authors provide some explanations of the differences between CW193 and

AERONET/CARSNET? Based on Figures 7-11, there are still some biases and differences.

Response: Thanks for your suggestions. As for the AOD from direct Sun radiance measurement, the main calculated method is based on Beer's law, in which the total extinction is mainly affected by aerosol extinction, water extinction, Rayleigh scattering and gas absorption (e.g., NO_2, O_3). Considering these variables and the assumption in the algorithm, the total AODs' uncertainty was 0.01 to 0.02 according to Eck et al. (1999). In this campaign, the calibration coefficient of CW193 was transferred from the master instrument of AERONET by inter-comparison. As reported by Che et al. (2009), the differences in coefficient transfer at 440, 675, 870, 1020 nm were about 2% between CARSNET and AERONET. In this study, the AOD bias was mostly concentrated within ±0.04 (4%), so we concluded the results of AODs were accurate with acceptable difference. For VSD, SSA and ADRF, these retrievals uncertainties, in fact, 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. 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 (Lines 427-436). 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.